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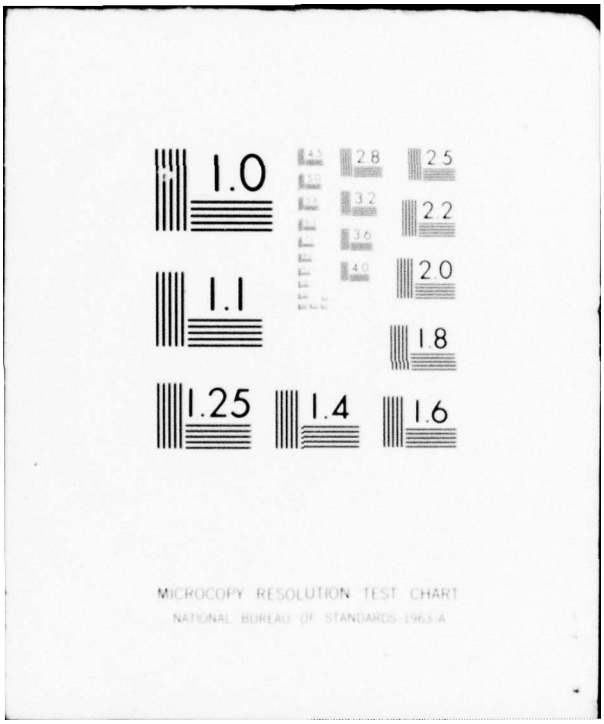
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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists by disclosing interesting information well in advance of the usual scientific publications.

The articles are written primarily by members of the staff of ONRL, with certain articles prepared by, or in cooperation with, members of the scientific

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staffs of the United States Air Force's European Office of Aerospace Research and Development and the United States Army Research and Standardization Group. Articles are also contributed by visiting Stateside scientists.

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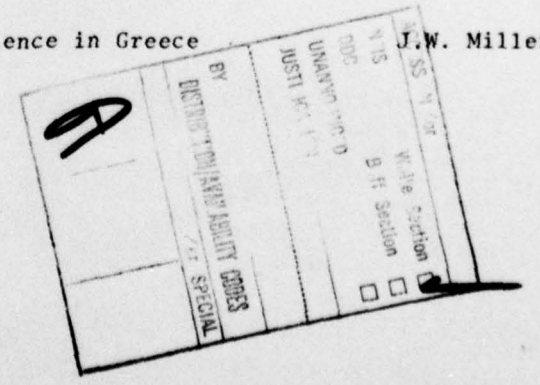

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Commanding Officer

BEHAVIORAL SCIENCES

BEHAVIORAL SCIENCE IN GREECE

For my last major trip on behalf of ONR-London, I chose to visit Greece to determine the status of research and training in the behavioral and the marine sciences. This article describes the former while a companion article describes the latter. During the trip I had occasion to meet individually with 27 scientists to discuss their work and the current status of research in Greece. In each instance the reception was extremely cordial and the discussions candid. Much credit for the arrangements should go to Mr. C.G. Peroyanyakis (Scientific Group for Space Research, Athens) whose assistance was invaluable both before and throughout my visit.

The development of behavioral sciences in Greece is in its formative stages compared to other European countries visited by the writer. The reasons for this lag are found in deeply imbedded academic traditions, a recent extended period of dictatorship, and the socio-economic status of much of the population. There are signs, however, that research in general and in the behavioral sciences in particular is receiving increased attention by government officials. There is a long road ahead though before anything approaching a substantial and well organized program will be achieved. For example, while individual courses in psychology are offered in several academic institutions, there is not a university degree program anywhere at the present time. The nearest approximation is a combined program of teacher education and psychology at the University of Thessaloniki. Currently there are five chairs for psychology in Greece, two at Thessaloniki (only one of which is occupied), two at the University of Ioannina in western Greece, and one at Athens University established in November 1976 which, unfortunately, may not be filled for one to two years.

In addition to courses available at the universities, there are three private schools in Athens which offer programs in psychology. One is Pierce College which is primarily operated by Americans. This school has a four-year course leading to a B.A. with emphasis on business administration, psychology, and human relations. Within the psychology curriculum, emphasis is placed on educational, clinical, and industrial psychology. Most graduates either accept jobs in private clinics in Greece or go on to graduate work in the US. The other two private schools in Athens are the Center of Liberal Studies and the Center of Humanistic Studies. The former is run by Dr. George Dolianides and the latter by his wife Dr. Maria Dolianides. Both offer four-year degree programs with emphasis also on educational, clinical and industrial psychology. Although these degrees are not recognized by the Greek Government, graduates are accepted for M.A. and Ph.D. programs in France and in some schools in the US. Because of the absence of formal university programs in psychology, most university students are interested in an overview of psychology or in taking specific electives in support of majors in other fields.

Discussions with various individuals revealed that there is an across-the-board shortage of professors in Greece and that about 70 positions are unfilled. The use of visiting professors has been tried but usually has not been successful. In the Greek higher education system, students can be examined on course material up to two to three years after completing the course. This means, of course, that the visiting professor may have long since departed. Consequently students shy away from such courses. While some students are willing to attend lectures by visiting professors for no credit, experience has shown that attendance drops off sharply after the first one or two lectures.

One of the institutions visited was the National Technical University of Athens. This University (founded in 1836) is devoted primarily to the training of engineers and architects. While principally located in central Athens, a greatly expanded (900 acre) complex is nearing completion in Zografos (an Athens suburb). I spoke with Professor J.A. Pappas, who holds the Chair for Industrial Management and with Mr. P. Iordanides, who is responsible for teaching ergonomics.

The primary role of this department is the teaching of production and industrial engineering, the only such program in Greece. In addition to courses in statistics, management techniques, cost control, etc., the department offers three courses in ergonomics, one introductory and two specialized electives. The last two courses include lectures and laboratory instruction on such subjects as: workplace layout; displays and controls; work physiology; environmental factors including heat, cold, noise, lighting, dust, etc.; and such related areas as selection and training of personnel. As far as I could determine, this is the only ergonomics program existing in Greece.

The specialized ergonomics courses, only a year old, have been well received by the 120 students enrolled, and Iordanides hopes that the material can be further expanded. Although officially research is part of the department's program, the combination of a large teaching load, red-tape, and lack of funds effectively prevents any being carried out. The overall five-year program in production engineering is application-oriented as is the training in ergonomics. The fact that graduates have little difficulty in finding jobs may be due in part to the liberal use of on-the-job training during the fifth year.

At Athens University I spoke with Mrs. Sophia Saka who currently is responsible for the psychology program. This program falls within the Faculty of Philosophy and consists of four courses: an introductory course (for second-year philosophy students or as an elective), a course in clinical methods, one in the psychology of personality, and one in developmental psychology, the last of which is in the Department of Education. Although there is currently no research perhaps the recently established Chair of Psychology will result in initiation of a program.

I also visited Dr. C.J. Tsimpoukis, Professor of Psychology at the National Academy of Teachers, 116 Kremou Street, Athens, who seemed to be extremely well informed about the status of psychology in Greece and, in the writer's opinion, would be the best contact for further information. He has written and/or translated several books and stated that he is one of the first to really push psychological research in Greece. The Academy's psychology program stresses research and teaching methodology. It offers, among other things, a two-year course in psychology which includes testing and measurements, research methodology, personality, and developmental psychology. To date about 200 teachers have participated in this program and then returned to their regular teaching posts. Tsimpoukis said that he expected to see formal degree programs in psychology evolve in the next two to three years, especially in the new universities where the classical system of academic chairs is slowly giving way to "university departments".

One of my most interesting visits was made to Eginition Hospital, a 200-bed psychiatric facility located in the heart of Athens. As part of Athens University, it is a teaching hospital as well as having a modest program in psychiatric/psychological research. According to Dr. C. Stefanis, Director of the Hospital, there are three clinical psychologists, one full-time and two on a part-time basis, in addition to the psychiatric staff. In speaking with Mrs. Anna Kokkevi (the full-time psychologist) I learned that her duties are primarily diagnostic and consist of administering psychological tests such as the MMPI, the TAT, and the Rorschach. Kokkevi said that in addition to problems stemming from cross-cultural differences, i.e., using tests standardized in one country for diagnosis in another country, there are very great differences between patients from Athens and those coming from small, (i.e.,long-isolated) Greek villages. This factor complicates the development or standardization of psychological tests in Greece in general, and in Eginition Hospital in particular, because most of its patients are from small villages. Nevertheless, Kokkevi is attempting to standardize foreign tests as best she can.

It turns out that psychological research in Greece is virtually all clinical in nature and is mostly being conducted by psychiatrists. Dr. A. Liakos of the Department of Psychiatry, Eginition Hospital, has for the past three to four years been studying the long-term (average 23-years usage) clinical and psychophysiological effects of using cannabis. His study consists of 47 cannabis

users and 40 control subjects, all of whom were carefully selected to assure a balanced experimental design. Parameters studied include general physical and neurological state, electroencephalography (EEG) and psychological and psychiatric status. It was found that for most parameters measured, the chronic users did not differ significantly from the control group. Those parameters which did demonstrate differences were influenced by other factors, so that no definite conclusions could be drawn. The complete results of the study will soon appear in a special publication of the New York Academy of Sciences.

Other research at Eginition Hospital includes: the development of new treatment procedures for use with obsessive-compulsive individuals; the experimental use of biofeedback of hypertensive patients (see ESN 30-10:433-435) and some basic EEG research in which responses to electrical stimulation of single cortical neural units of rats and cats are being measured. This latter effort, under the direction of Dr. A. Karabelas, is the most basic research effort I encountered in any of the site visits in Greece. Along these lines Dr. E. Garelis, a neurochemist at Eginition Hospital, showed me a publication produced by the "European Training Programme in Brain and Behaviour Research" (ETP). This *Directory of Brain and Behaviour Research* (1975) summarizes ongoing work in this field throughout Europe and is an excelleht reference document. Further information can be obtained by writing to Dr. H. Zwenk, c/o Medical Biological Laboratory, TNO, P.O. Box 45, Rijswijk 2109, The Netherlands.

The only organization engaged in sociology/social psychology in Greece is the National Center for Social Research in Athens. It was established in 1961 under the auspices of UNESCO and now is a government-supported facility under the Ministry of Culture. It employs about 80 persons, one-half of whom are professionals. There are 15 ongoing research projects according to Professor V. Filias, the Center Director. The most important three, in his opinion, are: "The Social Security, Health and Relief Work in Greece", "Administration of Penal Law in Greece, and the Working and Effectiveness of the Greek Penitentiary System", and "The Greek Megalopolis and Its Problems".

Filias said that in conducting this work various survey techniques are used. He finds that there are problems which are due to the reluctance of many people to answer questions. They are not used to being questioned and are suspicious that the survey is a ploy of the government to get information for the purpose of raising taxes, etc. Although this attitude is not surprising considering recent Greek history, it does complicate the job of an organization attempting to determine social attitudes.

In addition to discussing specific programs, I had an opportunity to discuss social science in general and how it is perceived in Greece. Mr. A.R. Protopapadakis (a former counseling psychologist and now a Member of Parliament) and Professor E.A. Moutsopoulos (a psychologist), the Vice-Rector of Athens University who will become the Rector next year, were among those with whom I talked. Throughout these discussions as well as others, the message that came through is that research in general, and in the social sciences in particular, is a luxury which is just barely affordable in Greece at the present time. Research in experimental, physiological and other branches of psychology, as thought of in the US, simply does not exist.

Although, on paper, research is part of their duties, university professors are really regarded as teachers and not researchers. Psychologists are not persons to whom Greek people go when they have emotional problems. If they seek help anywhere at all, it is from the church or from psychiatrists, the latter really being the principal group conducting research in clinical psychology. If psychology is to develop significantly in Greece, the present attitude of the Government will have to change. In all probability psychology will continue to be closely associated with philosophy, psychiatry, and pedagogy. In the opinion of several with whom I spoke, a major step will be when the Chair system in the universities gives way to the Departmental system. Many think this will happen slowly within the next few years. (J.W. Miller)

BIOLOGICAL SCIENCES

A DISCUSSION OF GRAVITY AND BIOLOGICAL SYSTEMS

About forty people met at the Royal Society's rooms on 6 November to discuss gravity and biological systems. I went there knowing only the title of the meeting, having by some mischance failed to receive a copy of the usual advance program and abstracts. I happened to arrive a few minutes late and was surprised to find Mr. H.S. Wolff (Clinical Research Centre, Northwick Park Hospital, Harrow, UK), the opening speaker, talking about "Spacelab" and its facilities. Spacelab, described as "the culmination of a major cooperative project between the nations subscribing to the European Space Agency (ESA) and NASA", is meant to carry a fairly ordinary laboratory and a few equally ordinary scientists into orbit. Over the next ten years, starting in 1980, something like fifty such expeditions are planned for the vehicle (an object comparable in size to a jumbo jet, capable of re-entry and normal airport runway landing) and its payload.

What will the fortunate scientists do with this unusual opportunity? The suspicion slowly grew during the course of the one-day discussion meeting that the pressing needs of scientific research were not among the decisive factors leading to the creation of Spacelab. One purpose of the meeting, if not the only one, was to help fill the vacuum by giving UK biological scientists interested in the role of gravity an opportunity to show how they could contribute to the advance of science (and to the *ex post facto* justification of Spacelab) by doing some well-conceived experiments while in orbit: a reasonable inference, perhaps, from the identity of the organizing group, representing the British National Committee on Space Research. An account of Spacelab will be found in the Report presented by the ESA to the 19th COSPAR meeting, Philadelphia, June 1976: European Space Agency, 114 Avenue Charles de Gaulle, 92522 Neuilly-sur-Seine, France. Various proposals for biological experiments in orbit have been considered by the Working Party on Aerospace Physiology and Medicine: Working Party on Space Biophysics, under the auspices of the Committee on Science and Technology, Parliamentary Assembly of the Council of Europe, Strasbourg.

After Wolff's, the remaining six papers at the Royal Society meeting were in varying degree accounts of basic research. The standards were high, although the Royal Society compromised itself slightly by printing in five out of eight abstracts phrases referring to "absence of gravity", "outside the gravitational field", "zero gravity", and the like. Honor was satisfied in the nick of time by circulation of a brief statement by Dr. T.D.M. Roberts (U. Glasgow) pointing to the elementary fact that the gravitational field 200 miles out is only about 10% different from that on the ground. The importance of free fall (and, he could have added, of whole body immersion on earth) lies in the redistribution of fluid pressures and of stresses upon mechanical linkages within heterogeneous objects.

The morning session dealt with animal experiments, the afternoon with plants. There were only two morning papers (aside from the one on Spacelab) and, interesting as they were, they suffered from a preoccupation with space travel and its physiological consequences. Group Captain P. Howard (RAF Inst. of Aviation Medicine, Farnborough) discussed entertainingly the comparative physiology of the circulation, the price paid for upright posture ("the giraffe, luckily for it, has a very small brain"), and the penalties accompanying and following upon acceleration or weightlessness. Howard is convinced that experiments done in orbit will have much to contribute to the understanding of the circulatory and neurological effects of water immersion and the subsequent incidence of orthostatic intolerance.

Prof. T. Gualtierotti (U. Milan) dealt with his vestibular function research program, one justification for which is the likelihood that vestibular disturbances are responsible for space sickness. Gualtierotti's technique for recording the resting firing rate of single neural units over periods of months is being adapted to space flight conditions. Complicated changes of discharge frequency with flight time have been observed but not explained. A cinema film showed the technique used for recording in orbit from the frog otolith organ,

a sensor of linear acceleration within the labyrinth, in which a neuroepithelium is stimulated by the weight of calcite crystals.

The four afternoon papers, in absence of a fifth author, Dr. B.E. Juniper (U. Oxford), who was sick, all dealt with plant movements in which gravity (i.e., weight) may play a decisive part. Why do roots go down and shoots go up? Why do some plants keep upright, on the average, only by growing in a spiral?

Spiral growth, or circumnutation, as the plant scientists call it, was discussed by Prof. A. Johnsson (U. Trondheim) with reference to three models and the experiments done systematically to decide between them. A growing shoot displaced from the plumb-line proceeds, after a 30-minute lag, to grope its way back towards the vertical. It does so by overshooting and an oscillatory process is established. Extended to three dimensions and with simultaneous upward growth, the result is a helix. Models reproducing features of this behavior mathematically include, at one extreme, a feedback system involving gravitational stress and gradients of growth hormone concentration. At the other extreme, inherent oscillations of growth hormone synthesis can be postulated leading to a wave of extension traveling around the stem. Tests of these and intermediate hypotheses include study of the effects--if any--of various operations such as "decapitation" and change of orientation upon the parameters (amplitude, period, damping) that characterize the oscillations. Clearly the quite reasonable idea of biochemical oscillations, already established in glycolysis, for example, implies that circumnutation would continue in the weightless condition, while with a gravity feedback mechanism it would be stopped. Johnsson is understandably eager to put the matter to the test in Spacelab.

Prof. M.B. Wilkins (U. Glasgow) described the accumulation of the growth inhibitor abscisic acid in the root cap of *Zea mays* (corn); it migrates downward in the horizontal root so that cell division is favored along the upper surface and the root bends downward. Prof. Dr. A. Sievers (Botanisches Institut, U. Bonn) went into more detail in the case of the root of another plant, *Lepidium sativum L.* Here the direction of growth is determined by the settling of amyloplasts (starch granules) upon a specialized endoplasmic reticulum (ER) complex; a sort of mould of the granules is formed, pressing the cisternae of the ER into a parallel arrangement which presumably provides the necessary conditions for growth. If the root is rotated with its long axis horizontal, the parallel arrangement is lost because the granules move away from the ER. Under some circumstances new ER formation is induced in a more advantageous position so as to restore the favorable juxtaposition of granules and cisternae and permit resumption of downward growth.

The upward growth of shoots was considered in Wilkins' paper already mentioned and by Dr. Daphne J. Osborne (Agricultural Research Council Unit of Developmental Botany, U. Cambridge). The active substance promoting cell division in the shoot of *Zea mays* is the growth hormone indole acetic acid (IAA). In the horizontal shoot it is the downward accumulation and accelerated longitudinal transport of IAA that causes unsymmetrical cell division, and makes the shoot bend upwards. Wilkins was particularly interested in the so-called phototropic responses of plants, which must be seen as the resultant of geotropic and true phototropic components, the latter being impossible to isolate under ordinary conditions. For this and other reasons the quantum dose-response curve for shoot bending is very complicated, with two null points, a positive maximum and a negative maximum over a seven-decade dose range at 436 nm. Experimental difficulties and interference from the geotropic contribution make it difficult to determine true action spectra so that virtually nothing is known of the pigment or pigments involved. Wilkins felt that this was the sort of problem that might well be solved in a satellite. Perhaps so; but I would prefer to think that human ingenuity on earth will either prove equal to the challenge or will formulate the problem in more tractable terms.

Osborne, with her co-worker, M. Wright, has been trying to find how a tilting stalk of the grass *Echinochloa columnum* manages to be restored to an upright position. The site of action is a purplish node situated at the base of the leaf sheath. It is a sort of joint or fulcrum,

though not articulated in the animal sense, but capable of unsymmetrical movement causing the stem to rotate about the short axis of the node, typically through 50-70° in 24 h. The nodal cells do not divide; they elongate. By means of ingenious experiments on the effects of endogenous and externally applied IAA on longitudinal sections of the excised nodes held in various orientations with respect to the vertical, backed up with histological and ultrastructural data, Osborne made a good case for the hypothesis that IAA synthesis is triggered by settling of granules (statoliths) upon the statocyte membrane. However, neither she nor Sievers quoted any values for the densities and elasticities of the several interacting cell components or the magnitudes of the forces resulting from differential buoyant densities. Perhaps the settling of statoliths merely changes the positioning of the components so as to favor relevant enzymatic processes. Equally little mention was made of the chemical identity of the statoliths. Presumably these are usually made of starch, which could itself present reaction sites. In the ensuing discussion, Sievers referred to the geotropically active rhizoids of a freshwater alga in which downward bending is probably triggered by the settling of intracellular barium sulfate particles.

The discussion periods during the meeting were enlivened by lengthy provocative interjections from Prof. R.L.F. Boyd, CBE, FRS (Dept. of Physics and Astronomy, University College, U. London) who let it be known that he was seeking from the biologists proposals that could match the significance of his own astronomical preoccupations in space. Betraying little sympathy with the world of experimental biology, he dismissed the several suggestions offered as too trivial to merit a place in what he referred to as a $200 million venture, although others pointed out that the eventual cost per experiment (and, I suppose, per trip) would be closer to $10,000. The biologists, it must be admitted, were rather passive in the face of this attack until Prof. N.W. Pirie, FRS--for 12 years Chairman of the Space Biology Committee--summing up the meeting gave rein to his well-known mordant wit with unconcealed enjoyment. The interest of some galactic and subatomic scientists in grandiose equipment, he seemed to say, was of the same nature as the infatuation of ordinary people with huge chromium-plated automobiles. In any case he could not see exploration of the backside of the universe contributing very much to the conquest of disease or the improvement of agriculture, although the authorities had made it clear that biological experiments in space would not receive consideration on an equal basis with astronomy unless their socio-economic significance could be established.

At the same time Pirie seemed surprised that UK biologists had not reacted to Spacelab with the same enthusiasm as their French, German and Italian counterparts. When a show of hands was suggested, only one--as far as I could see--of the UK biologists present expressed in this way a genuine commitment to the idea of taking part in the Spacelab program. There was some private bitterness that what had been construed as an invitation to discuss the possible contributions to basic biology of experiments in space had laid the biologists open to the reproach that they had not sufficiently considered the usefulness of what they proposed to do. There was also a feeling, privately conveyed, that there is a greater need for intellectual creativeness on earth than for expensive toys to be deployed elsewhere. These sentiments are easy to understand when one recalls that the UK rocket program, with its great potential for revealing important and perhaps useful facts about the stratosphere, was sacrificed upon the altar of Spacelab. (J.B. Bateman)

COMPUTER SCIENCE

THE SECOND INTERNATIONAL MEETING ON VERY LARGE DATA-BASES

As guest editor for the recent special issue of *Computing Surveys* (8, No. 1, March 1976) devoted solely to Data-Base Management Systems, E.H. Sibley (U. Maryland and National

Bureau of Standards) introduced the issue by saying: "Here we attempt an integrated approach to a very disoriented field. Problems abound: differences in terminology, differences in modeling and differences in implementation... While some problems appear more philosophical than real, others arise from a poor understanding of new concepts." To anyone who has had the experience of sitting through a three-day conference on data-base research and technology, the truth of Sibley's remarks is painfully clear. It is a "very disoriented field"; and it is difficult to grasp the new concepts, especially when such concepts are so glibly and obtusely defined.

Because data-base technology is a new, embryonic and very specialized subdiscipline, many ESN readers may not even be aware that still another priesthood has emerged in computer science. One indication of the extent of activity and the rate of growth of data-base research and technology is a 1975 survey conducted by A. Blaser and H. Schmutz (IBM, Heidelberg Scientific Center). This report lists 198 references, among which only 12 have publication dates earlier than 1970. In fact, well over half of their 198 references were published during 1974 and 1975.

In the jargon of computer science, the term "data-base" (alias "data-bank") refers to any computerized file of records. Personnel files, parts inventories, consumer credit files and "keyword" abstracting systems are all familiar examples of large data-bases. As more and more of the record-keeping and decision-making functions of industry and government have come to rely on information stored in computer-processable data-bases, the need for improved data-base technology has become increasingly acute.

The problems which arise with large (computerized) data-bases can, to a great extent, be appreciated by thinking in terms of conventional record filing systems. The problems with any data-base are not with the storage of data *per se*, but with the sorting, manipulation and retrieval of select information contained therein. For example, consider the personnel data-base of a large organization. The personnel record of each employee will contain all the information which the organization normally maintains on its employees. Now, if the only anticipated use of this data-base is simply to retrieve specific employee records, then there is no real data-base problem in the sense that it is trivial to recall John J. Jones' record from the file. Suppose, however, that one wants to query the data-base with questions such as: "Which employees in the organization make more money than their managers?", or: "Which managers have fewer than 10 immediate subordinates?" It is clear that the answer to this type of question requires that the individual employee records contain some information about the employee's position in the organizational hierarchy. Even then, since the files are indexed only by employee name, it would be an arduous task for a file clerk (hence, a computer) to answer these questions since he must first go through each employee record to discover which employees are managers and who are their subordinates; i.e., the file clerk must essentially extract an organizational chart from the raw employee record data-base. Once he has gone through the data-base record by record, the smart file clerk will compose an organizational chart which will greatly expedite the answering of similar questions in the future. Although the information contained in the organizational chart is not new information, it is now explicit rather than being buried in the raw data-base. The effect of an organizational chart is to associate or relate in a hierarchical structure heretofore separate records. For other purposes it will be more convenient to develop other types of association between the records, e.g., skill groups, salary groups, progression and succession chains, etc. One of the major goals of data-base research is to provide the methods and the computer software to enable an organization to design a "relational data-base" which will be most efficient in terms of computer time and computer system cost.

To compound the basic problems of constructing, storing, up-dating and manipulating vast quantities of computer-coded information, one must also meet the often diverse needs of various users who share and concurrently access the same data-base. These requirements, together with the need to insure the integrity (quality or validity) of the data-base, the

need to secure the data from unauthorized access, and the organization's desire to accomplish these objectives at minimum cost are some of the major stimuli for data-base research.

The Brussels conference on Very Large Data-Bases (VLDB) held on 8-10 September 1976 was the second of what will most likely become an annual affair. The first VLDB conference was held in Framingham, Massachusetts, in the fall of last year and attracted an unexpectedly large number of participants--370. The Brussels meeting, in contrast, drew an attendance of only 130. A total of 15 papers was presented covering a wide range of topics such as recent developments in data-base system architecture, approaches to the design of languages for supporting data models, methods of performance improvement, communication and conversion of data between different data-base systems, and applications support systems.

Although about 75% of the participants were from Western Europe, 23 of the 27 authors and co-authors were from North America and the UK. Of the remaining four, two were employees of IBM Germany (Heidelberg Scientific Center). The lack of active conference participation by Europeans seems rather curious. One reasonable conjecture is that, at present, their need for improved data-base technology is not as great as that of the US. It is also reasonable to believe that, considering the chaotic state of affairs in this field, they've purposely adopted a wait-and-see attitude.

IBM's heavy investment in research in data-base technology was evidenced by the fact that 13 of the 27 contributors were either IBM employees or acknowledged IBM's sponsorship of their research.

The stated purpose of the meeting was to concentrate on issues specific to very large data-bases, i.e., data-bases of the size one normally associates with the US Census Bureau, the Library of Congress, the FBI, or the personnel records of a large corporation. Most of the papers, however, as several people rudely pointed out in discussion sessions, dealt with problems and methodologies which are largely independent of the size of the data-base.

Most of the first day of the conference was devoted to papers and discussions of what has come to be called the "3-level data description model" of GUIDE-SHARE and ANSI/X3/SPARC. This model envisions three levels at which data are conceived of differently: The external view (External Schema) is the concept of data held by the applications user of the computer. In the External Schema, the particular application may suggest or dictate specific record formats, structures or logical relationships within the data-base. The actual physical layout of data (or an algorithm for allocating data storage) within the computer is termed the Internal Schema. Between the External and the Internal is the Conceptual Schema, the definition of which seems to vary greatly from one computer scientist to another.

There was more heated debate and discussion concerning the definition of the Conceptual Schema than on any other issue of the conference. One of the most succinct, if not altogether lucid, definitions of the Conceptual Schema was that given by Dr. William Kent (IBM, Palo Alto): "The specification of the information content of the data-base, employing concepts equivalent to entities, attributes, and relationships." Mr. Thomas B. Steel, Jr. (Equitable Life Assurance Society), the only US delegate to the Technical Committee on Programming (TC-2) of the International Federation for Information Processing (IFIP), offered: "The Conceptual Schema is a model of that portion of the enterprise which is essential for the data-base management system." An actual realization of a Conceptual Schema was envisioned by Steel as consisting of "a set of statements in the predicate calculus with integrity constraints". (This seemed to make sense to Steel himself.) In spite of the lack of agreement as to its definition, virtually all of the leading authorities agree on the need for a Conceptual Schema as an intermediary data model linking the Internal and External Schemas.

In order to have a better appreciation of the magnitude of the effort which the proponents of the Conceptual Schema envision, note how Kent, who was the opening speaker of the conference, sees it: "The conceptual model will be a very real computer-related construct, just like a program or a data file. An enterprise is going to have a large amount of time, effort, and money invested

in the conceptual model...Think of it in the same orders of magnitude as a program library, or a system catalog, or a payroll file. Think of cylinders of disk space and printouts many inches thick. Think of a small army of technical personnel who have been indoctrinated in a particular way of conceptualizing data, and who have mastered the intricacies of a new language and the attendant operational procedures."

Be that as it may, these remarks were only a prelude to Kent's main concern which was that, before embarking on an all-out effort to develop the first conceptual model and before international standards groups settle upon a specific form of conceptual model, it would be wise to question whether the file storage and record processing techniques which have been inherited from traditional data-processing are, in fact, the best methods to use in a conceptual model. These techniques of "record technology" include conventions such as: Each record has a fixed number of identifying fields (e.g., an employee record contains the name, Social Security number, age, etc., of an employee); each field is of fixed length; one field (e.g., employee's name) is designated as the "key" for the record. Kent feels strongly that the conceptual model should "reflect information, rather than data-processing technology". He suggested modeling the "enterprise" in a way which is "maximally independent" of contemporary data-processing technology. While he made a strong appeal for examination of alternatives to record technology, he did not actually propose any viable alternatives.

At present, there are a bewildering number of data models to be found in the literature. For this reason, the paper by L. Kerschberg, A. Klug and D. Tsichritzis (U. Toronto) is a welcome addition. Entitled "A Taxonomy of Data Models", the paper classifies a collection of 23 data models within a taxonomy framework consisting of graph-theoretic versus set-theoretic models, mathematical foundations, terminology, and semantic levels of abstraction. (Some of these models are of the 3-level GUIDE-SHARE and ANSI/X3/SPARC type just discussed and others are not.) In his presentation, Tsichritzis was careful to point out that the authors' intent was not to compare models, but simply to categorize.

In the same paper, it was interesting to note that the authors encountered the same difficulties as most newcomers to the field do in sorting through the literature, namely, "models use different terminology to describe the same concept, and the same terminology is sometimes used to describe different concepts."

In a paper which completes a set of four recent ones on Dr. Michael E. Senko's DIAM-II (Data Independent Accessing Model), Senko (IBM, Thomas J. Watson Research Center, Yorktown Heights, NY) and Dr. Edward B. Altman (IBM General Products Division, Palo Alto) presented a detailed discussion of the Physical Device Level of the DIAM model. DIAM-II is a modified version of Senko's original DIAM, which had four levels of abstraction. Since this is one of a series of quite abstract and technically detailed contributions by Senko, it would be difficult to summarize the results of this paper alone. However, the data-base theorist should certainly be aware of its availability.

In a paper entitled "Choosing an Efficient Internal Schema", Dr. Frank W. Tompa (U. Waterloo, Ontario) assumes that the Conceptual Schema and the "target machine" (i.e., the actual computer system in which the data-base will be stored) are both given. His methodology of choosing an efficient Internal Schema requires the construction of a library of permissible realizations for each abstract data type which may be used in the Conceptual Schema. It is claimed that automation of the proposed algorithm results in a thorough, yet efficient, evaluation of all alternative internal representations and thus ensures an efficient data-base representation.

Drs. D.R. McGregor, R.G. Thomson and W.N. Dawson (U. Strathclyde, Scotland) presented a paper concerned with "High Performance Hardware for Data-Base Systems". The LEECH (the name derives from its relation to the main central processing unit and is not an acronym) is a very fast and inexpensive processor capable of carrying out data-base manipulations. The conventional processor to which it is attached is responsible for scheduling the LEECH's activities and manipulating its storage facilities. It is designed to exploit the essentially repetitive nature

of most data-base operations wherein the same operation must be carried out on each record in a file. The basic philosophy of the Strathclyde group is that one should consider the use of special purpose hardware (and associated software) for specific problems. They argue very convincingly that the LEECH processor has several important advantages over both conventional processors and even specially extended systems. The presentation was well received and seemed to spark a great deal of interest.

The problem of communicating between different data-base management systems (DBMS) is a major inhibiting factor to information exchange in a computer network environment. This was the subject of a paper by Dr. E. Nahouraii (IBM General Products Division, Palo Alto) and Profs. L.O. Brooks and A.F. Cardenas (UCLA). The main contribution of this work was to propose and illustrate a new methodology for communication between different DBMSs. However, further work is still required to produce an actual demonstration prototype of their proposed technique.

Two other important facets of data-base technology are the integrity and the security of the data-base. By "integrity" is meant essentially the quality of the data. Here one is concerned with protecting the actual data against damage or contamination whether caused by accident or intention. Privacy or security of the data from access by unauthorized users is, of course, a major concern of any organization which has integrated all of its vital statistics into a large data-base.

Actually, only one paper, entitled "A Semantic Model for Data-Base Protection Languages" by Profs. H.R. Hartson (Virginia Polytechnic) and D.K. Hsiao (Ohio State U.), addressed either the integrity or the data security problems directly. This paper reported on the initial work toward the development of a new computer language for access control and, hence, data protection.

Another paper, however, entitled "A Deductive Capability for Data Management" by Messrs. Charles Kellogg and Philip Klaho (both from Systems Development Corp., Santa Monica) and Larry Travis (U. Wisconsin) dealt with some of the problems involved in designing a practical deductive inference processor to augment a data-base management system. In brief, a deductive processor allows the user to query a data-base about information which is not explicitly stored but can be inferred with a certain probability of correctness by combining specific facts in the data-base. This paper, the research for which was supported by the Advanced Research Projects Agency and System Development Corporation, outlines a technically impressive deductive processor based upon hypothesis testing using symbolic logic. The authors' choice of an elaborate example involving the computerized gumshoeing of two department heads in a fictitious company via an analysis of their family trees and their wives' bridge clubs was, however, of questionable judgement since it so clearly illustrated the insidious abuses which can be made of seemingly innocuous personal information data-bases. While one can appreciate the value of such an automated inference capability to any investigatory or intelligence agency, the chosen example seemed quite inappropriate for this audience. Indeed, the five-minute question session was monopolized by short speeches on invasion of privacy, computer snooping and the old question of the scientist's moral responsibility for the uses and abuses of his creative work.

Whether or not the special issue of *Computing Reviews* referred to in the opening paragraph was successful in presenting "an integrated approach to a very disoriented field" the interested reader may judge for himself. The Brussels conference certainly was not successful in this respect, but was very effective in exposing the technical and philosophical problems with which this subdiscipline is currently plagued.

The complete conference proceedings will be published within the next six months by North-Holland Publishing Compnay under the title *Systems for Large Data-Bases* (P.C. Lockemann and E.J. Neuhold, editors). In the US and Canada, North-Holland publications are distributed by American Elsevier Publishing Company, Inc., 52 Vanderbilt Avenue, New York, NY 10017.
(W.J. Gordon)

EARTH SCIENCES

PROGRESS ON THE WINTER (HF) ABSORPTION ANOMALY

The word anomaly is given to a phenomenon that is not understood, and the chance that clearing away such road blocks will lead to major new insights makes them prime targets for scientific investigation. The "winter anomaly" in ionospheric absorption of short radio waves is such a phenomenon, having first been observed by Appleton in the mid-1930s and remaining poorly understood despite four decades of study and conjecture. We refer here to the variability of the absorption of high-frequency radio waves, primarily in the ionospheric D-region at about 80 km, and not to other "anomalies" which have been noted over the years and are now generally believed to be fairly well understood, such as the F-region winter anomaly, which relates to high electron densities present in the reflecting layer of the ionosphere at much higher altitudes. D-region phenomena have been extensively studied (particularly in Europe) using the most obvious technique--the measurement of the field intensity of radio waves reflected from the ionosphere--and an impressively detailed morphology of the effect has resulted. Briefly, the day-to-day absorption of ionospherically-propagated short radio waves can vary in an unpredictable manner by several orders of magnitude in received power, with the maximum variability occuring in December and January. The maximum absorption in winter can be as high as, or higher than, in summer, and is "anomalous" then because the atmospheric ionization causing the radio wave absorption is expected to be higher when the source of ionizing radiation, the sun, is higher in the sky.

The effect is considered to be a mid-latitude effect since it is not observed within about 30° of the equator, and if it exists at high latitudes it is difficult to identify because of masking by ionization due to high-energy particles precipitated from the earth's radiation belts. Europe is somewhat superior to North America for observing the "winter anomaly" separated from precipitated-particle events because the auroral oval is farther to the north. It became apparent in the last decade, principally because of sounding rocket measurements, that the greatest variability in the ionization occurs in a fairly narrow altitude range between 75 and 85 km, with day-to-day variability of the electron density in this range as much as a factor of 10, even when measured at the same time of day or the same solar elevation. (This can also be viewed as the shifting of the height of a "ledge" in the electron density profile from the upper to the lower part of this region.)

A simplified model of the processes thought to determine the electron density in this altitude range can be used to illustrate current thought as to the direct causes of the variability. An expression for the steady state electron density is: $N_e = (Q/\psi)^{\frac{1}{2}}$ where Q is the ion pair production rate and ψ is the effective loss coefficient. Current ideas as to the causes of the variability involve both Q and ψ. It is noted that an order-of-magnitude variation in N_e requires a 100-fold change in Q or ψ alone, or in Q/ψ. Q is proportional to the product I x N, where I is the intensity of solar ionizing radiation and N the density of an ionizable constituent of the atmosphere. For the "undisturbed" D-region (without precipitated particles or X-ray flares) I is thought to be Lyman-α radiation and N the concentration of nitric oxide (NO). Satellite measurements have shown that Lyman-α does not vary substantially, and hence, large variations in Q must be attributed to changes in NO. An idea that has been proposed by a number of workers is that NO produced in auroral arcs can be transported to lower latitudes by diffusion and/or the general circulation, thus giving rise to the meteorological nature of the phenomenon and possibly explaining the observed tendency for some high-absorption days to follow geomagnetic disturbances by a few days. This theory is perhaps most plausible for that portion of the absorption taking place in the upper D-region, above 80 km.

Attempts to explain the variability of the electron density in terms of ψ variations have suffered

because of a lack of general agreement as to the processes that determine ψ. Models based on the best available collections of reaction rates measured in the laboratory do not explain observed phenomena; for example, the steady-state electron density they predict at 80 km is too high to be consistent with measured nitric oxide densities. Also, these models are not consistent with the observed solar angle dependence of electron density (which is often more nearly proportional to Q than to $Q^{\frac{1}{2}}$), and do not explain solar eclipse observations which show the electrons vanishing within seconds of the onset of totality. Most relevant here, they cannot explain an order-of-magnitude variation in the electron density, as may be seen by writing $\psi = \alpha(1+\lambda)$, where α is the weighted average or "effective" value of the recombination coefficient between electrons and positive ions, and λ is the ratio of negative ion density to electron density, a notation which is standard among workers in the field. The laboratory-based models hold that, although simple positive ions eventually convert to the more complex "water cluster" form: $H_3O^+(H_2O)_n$, substantial numbers of negative ions cannot form in the daytime at 80 km, their formation being inhibited by reactions with atomic oxygen. Thus $\lambda = 0$ and $\psi = \alpha$. Since α for simple ions is at most one order of magnitude smaller than that for the water-cluster ions, it is impossible with these models to produce a sufficient variation in ψ to explain the observed electron density variations.

A model has recently been proposed which is based on atmospheric rather than laboratory observations, and which can encompass all observed phenomena. This model postulates the existence of invisible aerosol particles, probably ice crystals formed on stabilizing nuclei of unknown origin, which can exist in neutral or ionized states. Evidence for their existence was provided in 1968 by the direct observation of their ionized form by a West German group using a Gerdien mobility analyzer, a result later confirmed by US measurements. A number of scattering measurements, both ultraviolet and visible, also tend to confirm the existence of particulates above the stratosphere. Their presence or absence can cause both α and $(1 + \lambda)$ to vary by an order of magnitude, giving a cumulative change in ψ of 100, sufficient to explain the electron density variations observed at 80 km. It might be concluded, then, that the 80-km winter anomaly is due to the absence of some constituent(s) necessary for the formation of the particulates, which are normally present in the D-region.

Both Q variations due to changes in NO and ψ variations due to the presence or absence of aerosol particles are candidates for the direct causes of the D-region winter anomaly, and I believe that both may turn out to be important. What is not yet clear is the nature of the mechanisms that relate these phenomena to other solar and terrestrial phenomena, such as sunspot activity, geomagnetic disturbances, and atmospheric temperature and transport, including a fairly well-established connection with stratospheric warming events. In order to establish these relationships it is necessary to observe a large number of quantities simultaneously in a concentrated effort. Over the last decade a number of "coordinated programs" to this end have been conducted, mostly in the US. These programs have led to advances, but the general decline in support for sounding rocket programs in the US has resulted in programs inadequate to study the phenomena completely. Specific weaknesses in recent years have been the lack of chemical composition measurements of the atmosphere, and the lack of an extensive supporting network of ground-based observations of ionospheric phenomena in the D-region.

As US efforts in this field have declined, European efforts have intensified, culminating in the most comprehensive study of the winter anomaly yet attempted. A meeting was held in Bonn on 4 and 5 October 1976 to discuss the results of this campaign, which took place in the winter of 1975-76. The experimenters exchanged data from a large number of measurements on two days of anomalously high radio-wave absorption, 4 and 21 January 1976. Twenty-three groups from seven European countries participated. Forty-eight successful sounding rocket firings took place from the range at El Arenosillo, Spain. Measurements were made of ionization, composition, meteorological quantitites and solar

radiation which were intended to be sufficient to identify the relevant physical processes. Extensive ground-based support was provided by experimenters in several countries. Although it would be premature to disclose the results presented at this meeting, which was for the exchange of preliminary data among investigators prior to the preparation of more formal scientific papers, I was persuaded that the results will lead to major advances in understanding of the relevant phenomena.

It is planned that the results of the European rocket campaign and of other recent efforts in this field elsewhere will be discussed at a session of the COSPAR meeting in Tel Aviv in June 1977. (L.C. Hale, USARSG and Penn State U., University Park, PA)

RADAR METEOROLOGY IN THE UK

The Royal Signals and Radar Establishment (RSRE) is located in Malvern, a small town perched on the side of a steep hill in southwestern Wales. Aside from being involved in research areas suggested by its name, such as microwave studies, radar design, etc., the Establishment also includes a group, started some 25 years ago, which works jointly with the UK Meteorological Office (Met. Office). They carry out basic research studies using radar as an effective tool to gather information on tropospheric motions. Dr. K. Browning of the Met. Office joined this group some 10 years ago and is now directing its research effort. This group includes 12 radar specialists from the RSRE and 24 meteorologists from the Met. Office. According to Browning, a radar-meteorologist, *per se*, does not possess enough breadth of knowledge in either of these fields, so he would much rather work with a group composed of specialists in both disciplines.

The group's research lies in two mainstreams, the first dealing with the study of atmospheric motions found in clear-air, and the second with the dynamics of rain systems. The difference between the two areas lies in the presence of naturally occurring targets, i.e., such as rain drops, dealt with only in the second. About 10 years ago US investigators showed that a radar operating on rather short wavelengths (about 10 cm) with a high transmitted power and a sensitive receiver could detect motions in an optically clear atmosphere by relying upon the inhomogeneity of the refractive index of the troposphere. As a result, this new method of probing can now "see" convective motions in the atmospheric boundary layer, lee-waves due to the passage of a stratified airflow over a mountain range and clear-air turbulence (CAT). Studies of convection in the boundary layer were recently carried out, with the branch of the Met. Office being responsible for the development of instrumentation (Cardington). A tethered balloon was used to carry special instrumentation at five different levels providing data on turbulent velocity and temperature fluctuations from heights well beyond the reach of normal instrumented towers and masts. The tethered balloon was placed some 11 km away from the radar site located at Defford, so that both systems were observing the same phenomenon simultaneously. One of the main findings of this experiment was that convective elements have a longer lifetime than was previously suspected. As a result, radar can be used effectively to follow the time evolution of these elements.

Formation of lee-waves is another phenomenon which can be studied by using the Defford radar. These waves are excited when a stratified atmospheric flow moves over a mountain range, a meteorological situation often encountered in south Wales. The presence of the mountain ridge induces air parcels to rise as they move over it. Because the atmosphere is stably stratified this vertical motion forces the parcels to oscillate and a train of standing gravity waves forms in the lee of the mountain. These waves have a vertical peak to peak displacement of some 300 m at a height of 2-3 km, their amplitude tending slowly to decrease with height. Their wavelength is about 25 km. In many cases this flow is quite steady and is evidenced by the presence of stationary clouds found in regions where the vertical motions generated by these gravity waves produce condensation. In the

past, radiosonde techniques were used to study these flows. Now with the 10.7 cm Defford radar, data on these lee-waves can be obtained up to 10 km in altitude and over a 50-80 km horizontal range. (For more information the reader is referred to *Q.J. Roy. Met. Soc.* 98, 415:73-85.)

Clear-air turbulence, or CAT as it is affectionately called, is an important problem in aviation. The Canberra aircraft of the Meteorological Research Flight flew through a train of large-amplitude billows in clear air which had been detected by radar at a height of 7 km, and showed that moderate turbulence is found near the crests of these billows. Browning's group has studied cases where such billows formed and documented the time evolution of these systems.

Research dealing with the study and the structure of rain systems (see also ESN 30-2:84) uses three radars located in Southwest England to obtain a three-dimensional picture of the precipitation pattern. In particular, analysis of extensive data from heavy warm-sector rainfall has shown that the presence of hills and mountains can result in substantial increase in precipitation. Radar can be used to obtain quantitative estimates of rainfall intensity from the intensity of the echo. A five-year project is underway to develop a network of automatic radar stations which will cover a wide area of Wales and Southern England and will transmit digitized echo-intensity data along telephone lines to a central processing point. The echo data are to be processed in real time at each radar site by means of low-cost minicomputers. In this manner the essential data can be stored, sorted or transmitted. These data will not only be used to study the mesoscale structure of precipitating systems and to improve "now" forecasting (3-6 hours), but the rainfall information can also be presented in an easily assimilated pictorial form and displayed on TV screens. I was shown color pictures of TV displays of precipitating systems in which various rainfall intensities appear in different colors. Provision for storage and playback of several of these pictures will provide animation which could be used to acquire a better feeling for storm movements and development. It is envisaged that such data will not only be used by airplane pilots, by forecasters and those concerned with water resource management but could also be made available to the man in the street. By dialing a certain telephone number he could receive this information on his home TV screen.

This group, by using the radar as an effective tool for tropospheric motion probing, is therefore able to see "the animal rather than its warts" (Browning's words) and is contributing substantially to the field of synoptic meteorology in the above mentioned areas. (A. Barcilon)

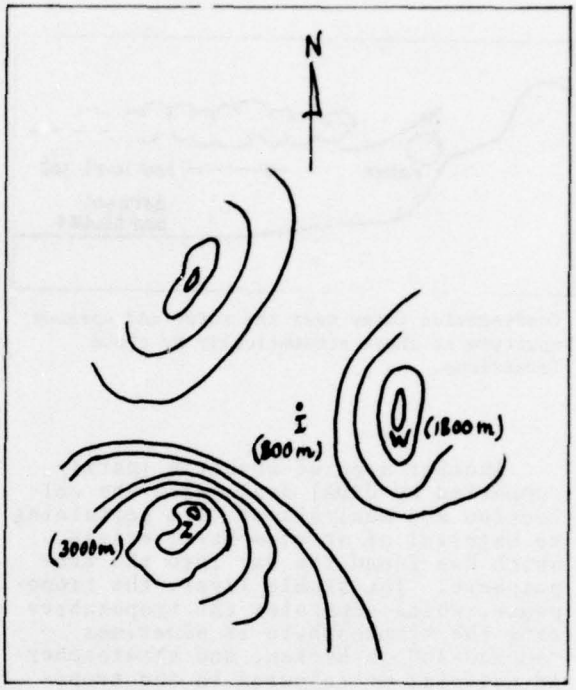
THE INSTITUTE FOR ATMOSPHERIC ENVIRONMENTAL RESEARCH, GARMISCH, FRG

The Institute for Atmospheric Environmental Research of the Fraunhofer Society is the new name (1973) given to the Physical-Bioclimatic Research Laboratory founded by Dr. R. Reiter in the late '40s. The Institute's research closely follows Reiter's interests. In the mid '50s Reiter obtained a US Air Force contract to collect and study data on atmospheric electricity in bad weather. He proposed to use mountains as platforms for his instruments; until that time atmospheric electricity studies had been carried out in fair weather and few investigators, like Benjamin Franklin, did investigate this phenomenon in bad weather. Reiter's contributions to this field were published (in German) in the book *Fields, Currents and Aerosols in the Lower Troposphere* (1964). The interested reader will be happy to learn that this work is being translated into English under the auspices of the National Science Foundation and should be available in the very near future.

Ionization processes depend upon the radioactivity of the air and soil and thus have a strong bearing on electrical phenomena. Therefore, from the original research in atmospheric electricity sprang a new interest in the study of radioactivity at different altitudes. About 1958, the German government began sponsoring the Institute on work pertaining to

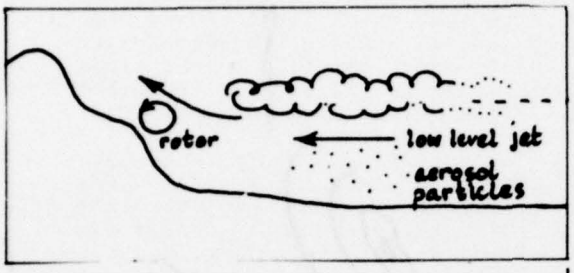
radioactive fallout. This branch of science carried with it the seeds of a new discipline, aerosol physics, for aerosol particles can carry radioactivity. Reiter is now using natural radioactivity as a tracer in a number of field programs designed to investigate convection and advection in the planetary boundary layer as well as in meso- and micro-scale meteorological phenomena.

The US Army, Air Force and Navy support some of this work by means of some small contracts while approximately 50% of the laboratory's support is block-funded by the Fraunhofer Society--a kind of Max-Planck Society having strong interests in applied science and engineering. The total budget of the Institute is about 2 x 10^6 DM (some $800,000); it supports a team of some eight scientists, a number of technicians and several sophisticated measuring devices used to collect atmospheric data (a high-power stationary lidar, a mobile lidar, radiosondes, devices for measuring electrical properties of the atmosphere, peripheral equipment that registers gas traces, etc.). Two additional meteorological stations in the immediate vicinity of the Institute are also used; one is on Wank peak at some 1800 m altitude and the other is on the Zugspitze at some 3000 m altitude. Aside from the conventional observing systems used to obtain meteorological data (wind, temperature, humidity, turbidity, aerosols, electrical properties of air and soil, radioactivity, etc.) a more unconventional system uses the cable-cars connecting the Zugspitze to the valley below to gather data. Instruments, mounted beneath these cable cars, sample atmospheric parameters as the cars move upwards. The data are then radioed to the Institute and recorded there. According to Reiter, the cable cars are sufficiently far above the ground (I can vouch for that!) so that the latter does not affect the measurements, which are comparable in quality with those taken by conventional radiosondes but are far cheaper to obtain.



The sketch shows the Garmisch valley and the location of the three stations: Z denotes the one on the Zugspitze, W the one on the Wank peak, and I the Institute.

One of the mesoscale meteorological phenomena for which data have been collected deals with the formation of a stratus cloud cover which rapidly spreads over the valley. Conversely, such a cloud cover is observed to dissipate in a very short time. A fascinating phenomenon occurs when a southward moving cold front, with its frontal jet, moves into the valley carrying large quantities of aerosols and hygroscopic nuclei collected as it passed over industrial centers such as Munich, which lies north of Garmisch. As this low-level jet reaches the obstructing mountain chain (Z), a rotor develops (see sketch); condensation starts near the rotor and rapidly spreads upstream, and within a few minutes the entire valley is covered with a low-lying cloud layer. This occurrence can be hindered or helped depending on local diurnal circulations induced by the presence of the mountains.



Condensation forms near the rotor and spreads upstream as shown schematically by cloud formations.

Another area of research (partly supported by ERDA) deals with the collection and analysis of data pertaining to material of stratospheric origin which has found its way into the troposphere. The stable layer, the tropopause, which separates the troposphere from the stratosphere is sometimes "sucked-in" or broken, and stratospheric material is injected in the troposphere. Some of this material might be radioactive and 2-3 day forecasts of radioactive fallout are needed. One proceeds by first detecting accurately where the stratospheric intrusions occurred, then one computes and follows atmospheric trajectories originating from these locations to determine where the injected material has been advected by the atmospheric motions. Strong peaks in radioactivity and gas traces detected on the Zugspitze correlate well with stratospheric dipping events occurring in the northern hemisphere and for which computed air-trajectories have passed over the Garmisch area. Also, using this technique, one can monitor the state of health of that delicate lady, the stratosphere, by studying and detecting the presence of various chemical compounds that might erode the ozone layer. Reiter feels that danger pertaining to the destruction of this layer exists, but our fears have not been substantiated by the quantitative analysis of the data. It appears that the latest threat to that layer might arise from the NO_x compounds used in fertilizers; these compounds diffuse slowly upwards. Conservative estimates seem to indicate that this effect might be the most serious threat, overshadowing those due to chlorofluorocarbons and stratospheric air-traffic.

In conclusion, this small team of scientists using sophisticated equipment has been accumulating unique data which should provide theoreticians with an excellent basis on which to test models of meso- and micrometeorological phenomena, as well as stratospheric modeling.
(A.I. Barcilon)

ENGINEERING

THE 14TH INTERNATIONAL UNION OF THEORETICAL AND APPLIED MECHANICS CONGRESS: "FROM DELFT TO DELFT"

The 14th International Union of Theoretical and Applied Mechanics (IUTAM) Congress held in Delft, The Netherlands, from 30 August to 4 September 1976 represented a return after an interval of 52 years to the scene of the 1st IUTAM Congress; hence the Congress title: "From Delft to Delft". In fact, the first congress in Delft was not really the first meeting of the group which later was to become the IUTAM. That meeting, denoted as the 0th Conference, was held in Innsbruck, Austria; its participants included such luminaries as Von Karman, Levi-Civita, Prandtl, Burgers, Oseen, Trefftz, and Ekman. J.M. Burgers, one of the few survivors, noted "there were 33 participants, six Dutch including me."

The Congress was opened with remarks by Prof. W.T. Koiter (Tech. U. Delft), Vice President of IUTAM. It was announced that the famed mathematician-elastician, Prof. N.I. Muskhelishvili, had passed away some months previously. Koiter also noted that A.S. Monin of the P.P. Shirshov Institute of Oceanology of the USSR Academy of Sciences "was not included on the list of attendees" from the USSR and hence could not present his invited paper entitled "Hydrodynamic Weather Prediction". Throughout the Congress, it appeared that the chances of hearing a scheduled paper by a Russian author were uncertain. The indication that freedom of scientific exchange was not being permitted by

the Russians was deplored, and the statement to that effect by Koiter along with hopes that there would be improvement in this regard was warmly applauded.

The Congress featured general lectures by H.B.G. Casimir (Philips Research Lab, The Netherlands), J.H. Argyris (U. Stuttgart), Y.C. Fung (UCSD), G.K. Batchelor (U. Cambridge), and C.C. Lin (MIT), on topics involving mechanics ranging from biomechanics to spiral galactic structures, and sectional lectures by specialists in the various sub-fields of mechanics such as classical mechanics and various aspects of fluid and solid mechanics. In addition, there were some 200 contributed papers presented in 7 parallel running sessions over a period of 6 days.

In the area of turbulent flows, the writer heard papers concerning experiments studying coherent structures in channel and stratified flows. It was reported by H. Eckelmann and H.P. Kristin (Max Planck-Institut, Göttingen) that rotating structures were observed close to the boundary in a turbulent channel flow by making space-time correlations of data taken simultaneously from arrays of hot film probes. A paper on phenomenological theory of wall turbulence by M.A. Goldshtik and S.S. Kutateladze (Hydrodynamics Institute, Novosibirsk) was read by someone else in the absence of the authors and thus discussion of the theory was prevented. The theory seemed capable of deriving "average" properties of turbulent flows along walls from "first" principles using a quasi-linear theory (Orr-Sommerfeld Equation) along with a "principle of maximum stability of mean-turbulent flows". It was too bad that the authors themselves were not present to clarify and illustrate the derivation and application of these ideas.

An invited sectional lecture "Complex Turbulent Flows", by P. Bradshaw (Imperial College, London) was concerned mainly with "complex distortions of interactions which significantly affect turbulent structures". Examples of flows studied included boundary layers in straight and curved ducts, straight and curved mixing layers, plumes in boundary layers, separated flows, corner flows and stagnation point flows. The subject was very interesting but the paper did not really address the problem of turbulence in a flow subjected to successive excitations of a different nature from that which first caused the turbulence. However, the complexity of the problem of turbulent flows is such that almost anything that can be correctly said about it is to be appreciated.

A session on turbulence contained papers in homogeneous and isotropic turbulence (an area of great difficulty and questionable return for effort in my opinion), propagation of shocks through a random medium, and distortion of turbulence by bluff bodies. The propagation of shocks in a random medium was studied by filling a limited volume inside a shock tube with turbulence caused by fine jets of helium and carbon dioxide and then passing a shock through the region. Data obtained via high speed Schlieren and shadowgraph movies were reduced to obtain statistical information about the turbulence. Pressure observations of the wave field before and after the scattering region illustrated the effect of the turbulence on weak shock waves. The paper on distortion of turbulence by bluff bodies discussed the effect of the presence of a body in a turbulent flow field where the turbulence scale varies from much larger than, to much smaller than, the major dimensions of the obstructing body.

A session on stratified flow was concerned with structure of turbulence in shearing flows, instabilities and wave propagation, internal wave dispersion, spin-up, and limiting thickness of stratified turbulent shearing layers. F.K. Browand and C.G. Koop (USC Los Angeles, CA) used dye and shadowgraph techniques along with hot film and conductivity probes to study the flow-field properties of a turbulent mixing-shearing layer between two stratified regions of water with different salinity (density). The limiting Richardson numbers along with visual wave breaking and with dominant vortex scales were obtained.

In a session on laminar boundary layer and transition, further developments in laminar-turbulent transition of a wake excited by strong external sound waves were described. Although, when it was first discovered, the gross effect of the sound on the flow was seen to be striking, it now seems

difficult to push this particular experiment to obtain more fundamental results. A paper on an experiment by F.H. Busse (UCLA) on transition to turbulence in thermal convection illustrated graphically the now well-known transitions through a series of different modes en route to turbulence.

In all, the Congress was lively--many individuals who knew each other through their work had opportunity to make and/or renew personal acquaintance, and the usual batting average of good papers out of the total was recognizable. In common with other such meetings, the reading of papers which were either small extensions, rehashes, or repeat performances of the past was noted by many of those present. If the number of such papers at conferences and in the literature were reduced, it would make it easier to keep abreast of developments in a field and to enter new fields. As I had to leave the conference at the beginning of the 4th day, no attempt to review unattended sessions has been made.
(Martin Lessen)

HOCHSCHULE DER BUNDESWEHR, SOUTHERN STYLE

In the April issue of ESN (30-4:157) I described the Hamburg campus of the Hochschule der Bundeswehr (HDB), and some of the political and educational philosophy that had gone into the founding of this institution for higher learning in the German armed forces. While in Munich recently I visited the other HDB campus which is being established to handle some 2600 students in the engineering fields of aerospace, civil (structures), and electrical, as well as in economics, computer science, and pedagogy. As was the case in Hamburg, the Munich program is being built from the ground up, with a good deal of innovation to be found in academic procedures as well as facilities. The campus is planned for completion in about two years (about one year after the Hamburg campus) and a visit there now involves a good deal of slogging through mud, but if the environment was damp, this had no apparent effect upon the enthusiasm of the people involved!

My hosts at the HDB-München were the staff of the Department of Aeronautics and Aerospace Engineering. The Chairman of the Department is Prof. F. Hindelang, who recently vacated a chair in fluid mechanics at the Technische Universität (TU) München. Hindelang has brought with him to the HDB his considerable reputation and continuing interest in nonequilibrium real-gas effects, and in spite of the early stages of facilities construction there is ample evidence of intended experimental research in this area. Hindelang has a number of staff working with him including Dr. K. Hornung and Mr. K. Knapp, both of whom are planning to use a shock-tube facility that is now undergoing shakedown tests. Hornung will extend his prior interest in solid-state shock effects to include shock waves in two-phase media. Knapp is now involved in the details of getting the shock-tube running, but having done so he intends to prepare a dissertation based on experiments involving the use of laser radiation instrumentation to probe the behavior of shocked gases. If successful, Knapp will obtain his degree under the auspices of TU München, since the HDB does not at present have the authority to grant the doctorate.

Prof. L. Römer is also interested in fluid flow, but at a much lower Mach number. Having only recently arrived at the HDB, he is, in fact, still holding down two jobs--his newly acquired academic responsibilities and his management position with the research section of the nearby industrial firm, Kraus-Maffei. Römer's main concern right now is with the installation of a new atmospheric wind-tunnel which will be a facility unique in Germany. The test section of the open-circuit tunnel is to be 2 x 2 x 20 m and features a flexible ceiling, a system of upstream wall roughness for simulating the velocity distribution in the atmospheric boundary layer, and a floor heating and cooling system for controlling thermal gradients in an effort to maintain Richardson number scaling. The tunnel will have a speed-range of 0.5 to 40 m/s and at the nominal speed of 10 m/s the thermal control system will provide temperatures in the range of 150°C above to 25°C below local ambient conditions.

The tunnel has been designed (by Siemens) and Römer now awaits approval of the installation by the Deutsche Forschungsgemeinschaft (DFG--German Research Association). This autonomous organization plays several important roles in the support and guidance of German research, including the sponsorship of Sonderforschungbereiche (special areas of research) which have been mentioned in previous ESN articles (e.g. 29-12:527). In the case of Römer's wind-tunnel, the DFG exercises final approval authority over its construction, as is the case for all German research facilities costing over DM 15,000 (about $6,000). Even though the funds for the tunnel have been allocated to the HDB (by the German Defense Ministry) its procurement must await the DFG approval of Römer's proposal which has been distributed to experts for vetting, much in the same way as manuscripts are reviewed for publication. The system is designed to minimize redundancy and maximize efficiency in the selection and location of German research facilities. Inevitably there are some politics involved--those who belong to the "clubs" tend to get better service--but Römer feels that the system is basically fair and effective. I was amazed to learn that the DFG usually is able to give their decision, based upon the recommendations of several reviewers, in a matter of one to two months.

Real-gas behavior is also a central interest in thermodynamics which, together with fluid mechanics, constitutes the other main area of research interest in the Department. Both Professors D. Straub and R. Waibel are involved in activities associated with reaction kinetics, combustion, and the general experimental characterization of gases and mixtures. They are assisted in these projects by four PhD-type researchers who are at present mainly occupied with the installation and check-out of new experimental facilities. These include a 250-kW plasma heater that will provide a medium for combustion studies and the behavior of materials under high-temperature jet impingement. Instrumentation will include laser-Schlieren flow visualization and Raman scattering of laser radiation. Also in the installation phase is an instrumented pressure vessel capable of obtaining 600 K and 300 bar for determination of the critical-point properties of gases and mixtures.

An especially interesting, if somewhat product-oriented project is the creation of metallic whiskers by a process invented by Prof. A. Walz (at U. Karlsruhe). In this scheme a stream of molten metal is injected near the throat section of a supersonic jet in such a way that the cooling and shearing effect of the jet produces a cloud of metallic whiskers that are especially uniform in their geometry and strength. The whiskers are to be used as matrix fibers in high-strength composite materials.

At Munich I found the same atmosphere of academic experimentation that prevails at the Hamburg campus of the HDB. The faculty is well aware of opportunities for innovation and challenges to succeed. As far as their being officially accepted by the German academic community as a whole, there is an element of futility since the HDB is proposing to do in 3 years what their traditional counterparts take 4.5 to 5 years to accomplish. Thus an admission of success at the HDB will in the minds of some traditionalists be tantamount to an admission of non-success at their own institutions. This is not necessarily the case, however, since many factors at the HDB (such as mature full-time paid students, and intense academic and community environments) point to a unique ability to accelerate the learning process. Sometimes pressure is antithetical to understanding, however, and just how much compression is academically feasible is a crucial issue at the HDB; they are even now beginning to talk of a 3.5-year curriculum.

Acceptance of the HDB program by the German academic community is vital, of course, perhaps even more than one might think because of the situation in the German military. The standard tour of duty for the German officer is twelve years. Many of them will become civilians, therefore, at the mid-region of their professional careers. Their main educational qualification will be a diploma from the HDB, and if this is not proven to be an indication of potential high performance in the civilian sector then the HDB will be actually

doing a disservice to its officer-students. This is the central concern of many of the staff, but there is a large measure of confidence that success is possible. This confidence is exemplified by Römer who told me that he would never have accepted a professorship at the HDB if he did not firmly believe that his students would be fully qualified to enter Germany's industrial community upon completion of their military service. (R.H. Nunn)

FAILURE PREVENTION BY WEAR MONITORING: A FIELD FOR ENGINEERING SUPERSLEUTHS

The reputedly high costs of mechanical wear have been a major matter of concern. Particularly portentous for equipment suppliers are the consequences of a potential failure leading to a major catastrophe--e.g., an aircraft crash. Accordingly, it is not too surprising that a one-day (24 November 1976) review of "Wear and Contaminant Monitoring Techniques" attracted an audience reported as 120, with 9 from outside the UK. The seminar, sponsored by the UK Mechanical Health Monitoring Group, was held in Leicester under the direction of R.A. Collacott of Leicester Polytechnic. The Monitoring Group held its inaugural meeting in March 1975 and a subsequent one on Vibration Monitoring in November 1975. More frequent meetings are planned. The Group membership is currently about 600.

The content of the seminar is accurately reflected in the title. Except for a brief debate on this point at the end of the meeting, no discussion was given to underlying causes of wear. In fact, while some individuals orally supported the need for reasonably fundamental studies, it was clear that few, if any, of the audience felt that such studies would be of consequence in the near term and, therefore, emphasis on monitoring techniques is well placed.

With the exception of the last one, all of the papers dealt explicitly or implicitly with wear in an oil-washed environment. G. Pocock (Admiralty Materials Laboratory) presented an introductory overview of contemporary techniques, including spectroscopic oil analysis (which, when the word procedure is appended, gives rise--not accidentally--to the acronym SOAP), magnetic plug analysis (MPA), ferrography, and particle counting. He also enumerated the analytic tools of x-ray fluorescence (XRF), atomic absorption (AA), and atomic emission (AE), to which later speakers added neutron activation analysis (NAA), optical microscopy (OM) and scanning electron microscopy (SEM). Pocock enumerated some advantages and disadvantages for each technique (e.g., SOAP is inexpensive but slow, requiring a large number of samples), leaving more details to later speakers. His appeal for the use of several techniques concurrently was largely ignored by subsequent speakers, each of whom presented his technique much in the tones of a muted evangelist. In fact, subsequent presentations and discussions appeared to give rise to several likely conclusions.

1. No single monitoring technique is superior to the others. Factors such as application, cost, and response time eventually dictate the choice of technique. For example, a representative of British Airways stated that they are entirely satisfied with MPA and feel that the (rough) cost of £1 per plug is entirely reasonable.
2. No single monitoring technique will perform well in all applications.
3. Elaborate and impressive atlases of wear products can be, and are being, developed for particular situations. This is amplified below. However,
4. It is probably unlikely that a universal atlas of wear products is feasible. This conclusion is probably firm, if the goal is an atlas which leads directly to wear monitoring. A guideline atlas may be feasible.
5. With an atlas of wear products relevant to the particular application, it is possible to predict failures well in advance and to identify the particular component responsible for the products.
6. Wear-product monitoring is generally highly operator-sensitive.

A.E. Hall (Ministry of Defence; Quality Assurance Directorate) described SOAP. The SOAP technique is extremely simple in concept. Oil samples are routinely taken from the lubrication system and analyzed for foreign inclusions, presumably wear

products. In his introduction, he stated that the value of the equipment under their jurisdiction typically is worth from £10^3 to £10^6 per item (e.g., helicopters and tanks) and that their main items which require monitoring for failure are gear boxes and bearings. Accordingly, they routinely check for Fe, Al, Mg, Cu, Ag, and Cr in their elemental analysis. They also check for Zn and Si; Zn is a typical inclusion in mineral oils and Si is common to dust and greases. In applying SOAP, their average monitoring time is 25 hours; they analyze about 30 x 10^3 samples per year.

Hall dwelt on AA and AE, for analysis, since he feels that (for his purposes, at least) XRF is limited by insensitivity to light elements (e.g., Mg: about 10 ppm) and NAA is too costly and time-consuming. He described AA as very good in the low limits of particle concentration detection that can be achieved, for the low initial capital investment and for the good available standards, but he found AE is more appropriate (again, for his purposes) since AA is time-limited by the need to use a particular lamp for a particular elemental analysis (e.g., a Zn hollow cathode lamp for detection of Zn). In contrast, AE can perform simultaneous analysis of many elements; the sample is excited in an arc and elemental considerations arise only in the interpretation of the spectra which are obtained. These spectra can be very complex, however.

Hall cited the importance of monitoring the character of the oil at all times, so as not to confuse the wear patterns being monitored. The difficulty of AA spectra interpretation had precluded Hall from analyzing for W and Ti. His rationalization for accepting this limitation in technique is that W and Ti are components of hard materials and it is likely that softer components which mate to these will wear first.

P.A. Mucklow [Rolls-Royce (1971) Ltd.] concentrated on MPA. Once again, the method is simple in concept. Magnets are judiciously placed in the oil lubrication system. These "plugs" are routinely pulled and their particle accumulation examined. A goal is 90% particle collection efficiency, but 50% is acceptable. To meet these figures, the design of the housing in the neighborhood of the plug is important. Hall showed two different "pocket" designs, in which the plug is positioned in the oil line so that the straight flow of the oil is disturbed. He also referred to a vortex chamber arrangement which is particularly efficient. Upon questioning, he stated that there is little dislodgement of debris in time in any of these arrangements, even under rude mechanical treatment. Mucklow volunteered to send a booklet describing Rolls-Royce experiences to those requesting it.

The "chips" that are obtained from the plugs can be analyzed in various manners. Mucklow particularly cited SEM analysis, described in more detail in the next talk. He also gave some comparison between MPA and SOAP, concluding that the two are largely complementary in capabilities and limitations, but he then went on to say that MPA may be entirely sufficient by itself in analysis of modern engines, providing that high standards of inspection are maintained. He does not regard the basic limitation of MPA to magnetic particles as serious, therefore.

Mucklow also briefly cited alternative monitoring techniques being considered or developed. Collection on a gauze in the oil line was given little praise. He cited an electrical technique which is proprietary, although he did state that it has a high temperature-dependence which is troublesome. He was particularly laudatory of an induction-coil technique, but gave no details.

Two other investigators from Rolls-Royce followed Mucklow. The first gave a case history of a failure that was detected in an engine of a pre-production Concorde aircraft (Engine #83). Magnetic chips were sent from Toulouse to the failure detection center at Bristol. The relative elemental composition of the chips--Fe mainly, with W, Ni, Cr, and V--pointed to an alloy known to be in either of the two main bearings. Subsequent examination of the engine verified the conclusions of the analysis. The bearing was replaced and the manufacturer improved the grinding operation that had given rise to the prob problem.

The chip analysis is performed by energy-dispersive x-ray analysis in a Stereoscan SEM. It is indicative of the current state-of-the-art in

wear analysis that the second of the two speakers devoted his talk to describing the basis and methods of the analysis technique. One point was emphasized. The success of their analysis does not depend on obtaining precise absolute elemental analysis. Their technique uses a "ratio-method", wherein the easily obtained relative concentration (e.g., Cr to Fe) is crucial. The chairman of the seminar, A.E. Davies, also at Rolls-Royce, explicitly underlined the importance of electron microscopy for future wear analysis.

Ferrography, discussed by D. Scott (National Engineering Laboratory), is another widely-used method. Scott's discussion was most interesting in some of the attendant details. He showed slides of the characteristic shapes that wear particles give in bearing wear, correlated with the amount of debris as a function of operation time. Initially, a relatively large amount of debris is collected, and is characterized by the random shapes of the particles. There then follows an extended period of time in which mild wear predominates; the debris consists mainly of disk-shaped particles. Finally, the rate of debris collection increases rapidly, pointing to early failure. The particles observed in this critical phase are spear-shaped, a fact which certainly is closely related to the mechanisms of failure. Scott has defined an index-of-wear which is based on this debris pattern. This index is proportional to the difference in square of the average area of large debris particles and the square of the average area of small particles. Further diagnostic information can be obtained by heating the debris and observing the resulting colors of the particles. Varying oxidation products give clues to the failing material.

S.A. Holding (Shell Research, Ltd.) devoted his time to a somewhat detailed discussion of AE, a method he clearly has worked with extensively. While praising its capabilities, he did acknowledge that only small amounts of a sample can be analyzed in one batch--about 10 µl. As a result, the need to obtain good statistics requires multiple sampling.

T.W. Conlon (Atomic Energy Research Establishment, Harwell) gave a paper which contrasted with all of the rest. He described a thin-layer activation technique under development at Harwell. The essence of the technique is to irradiate parts, prior to service use, with positive ions. A typical example would be an irradiation with deuterons accelerated through several million volts, to a total fluence (dose) of 10^{16} cm^{-2}. Penetration of these ions is limited to a few microns, typically. If the material contains the appropriate atoms and the bombarding ions are suitably selected, a small fraction (about 10^{-6}) of the atoms (nuclei) in the material is transmuted to a new radioactive species. Fortunately, it is possible to use this technique with such common atoms as Fe, Al, and Cu, among others, and produce radioactive nuclei that are gamma-ray emitters with activity half-lives of days or weeks. The induced activity is biologically harmless, according to Conlon, and the sensitivity is better than any existing techniques; a resolution of 0.5 µm is possible. Furthermore, the technique does not necessarily depend on oil transport and accumulation of wear debris. Machine parts can, in principle, be examined *in situ* for activity.

The potential of the thin layer activation technique is clear. Feasibility and economy of the method remain largely unexplored and will probably depend, as usual, on application. Conlon gave the accelerator charges as £75 per hour which is, in itself, very low. The pertinent question is: what does this figure translate into when an entire aircraft motor is involved? If the technique does achieve a good degree of technological utilization, it may have to be coupled with an intelligent selection of critical surfaces in a device, to bring the scale of the irradiation within realization.

The impression that this meeting left with this reviewer was that wear monitoring is currently in a reasonably satisfactory condition but that improvements and new techniques are needed and, most likely, forthcoming. One curious item came to my notice by virtue of its absence. Clearly wear monitoring is part of the whole study of wear, and "the study of friction, lubrication, and wear of moving parts in machinery" is a definition of tribology. Despite this, I do

not recall hearing any reference to tribology during the entire proceedings! This must be viewed as surprising, at least, considering the substantial tribology effort that has been mounted in the UK in the last decade (see ONRL R-7-76, by R.H. Nunn and H. Herman: "An Industrial Technology Called Tribology--the UK Experience and Its Implications"). Whether one should draw ominous conclusions from this single observation or whether it merely reflects a division of artisans into those who monitor wear and the remaining tribologists is unclear to me. (A. Sosin)

THERMO AND FLUID DYNAMICS RESEARCH AT TU MUNCHEN

The Technische Universität is situated very near the Munich town center and is similar in external appearance to the many historical edifices by which it is surrounded. Within the imposing and somewhat austere stone walls, many of which still bear the scars of war, there is an atmosphere of nostalgic progressiveness where, for instance, automatic data acquisition systems are utilized in steam condensation experiments in the same rooms where Carl von Linde worked to perfect the process of air liquefaction. My visit there included the Institute for Thermodynamics and the Institute for Fluid Mechanics, both of which are within the Faculty of Mechanical Engineering (Fachbereichs Maschinenwesen).

About 600 students enter the M.E. program each year at TU München, and two-thirds of these survive preliminary exams and go on to complete the program which leads to the Diplom-Ingenieur after 4.5 to 5 years. There are about 25 Lehrstühle (Chairs or Institutes) within the M.E. Faculty, and these operate together and separately to provide an initially broad and (in the last two years) progressively more focused educational program, including a thesis and final qualifying exams.

The Lehrstuhl A für Thermodynamik is headed by Prof. Dr.-Ing. U. Grigull whose temporary assignment to University administrative duties has caused him to leave the Institute in the hands of Dr.-Ing. J. Straub. Straub described the thermo aspects of the curriculum which are standard with two possible exceptions: (1) there is no chemical engineering program except as it exists as part of M.E.--all students are exposed to basic chemical engineering and can specialize in their later classroom and thesis work--and (2) thermodynamics at TU München means a more-or-less equal mixture of physical chemistry and heat and mass transfer--the two subjects are treated in a fashion that seemed to me to be rather more integrated than in corresponding US curricula. The upshot of these policies is an M.E. graduate with a goodly amount of chemical engineering thermodynamics linked with transport phenomena. Part of the development of this approach is probably due to the influence of the notable ancestry of the Institute which, besides Linde, includes Wilhelm Nusselt who held the chair from 1925 to 1952 and was followed by Ernst Schmidt who was "The Professor" until 1960.

A tour of the Institute includes a display of equipment that is primitive by present-day standards but nevertheless, in the hands of these pioneers, has led to results that survive as landmarks in the annals of heat and mass transfer. Today the research programs (at least the ones I saw) are still mostly experimental in nature, but the laboratories are well equipped with modern and sophisticated equipment and instrumentation. These projects may be categorized as being concerned with basic thermodynamic properties, multi-phase and convective heat transfer, and gas dynamics.

In several experiments the properties of substances near their critical points are being investigated by means of an unique optical apparatus to determine the refractive indices of the various phases and thereby their densities. W. Rathjen is measuring the surface tension of water over a range of conditions from the triple point to the critical point. Along with the refraction measurements to characterize the liquid/vapor state, he optically measures the rise of the liquid in capillaries to determine surface tension. A considerable amount of experimental finesse has gone into the design of this apparatus,

which must withstand high pressures and excursions from cryogenic to critical point temperatures.

K. Scheffler is working to determine accurately the vapor coexistence line of water and heavy water near their critical points. These and several other experiments are part of a program to improve present equations of state for pure substances and mixtures near the critical state. In another experiment related to critical point properties, H. Becker is using a holographic real-time interferometer to determine the thermal conductivity of CO_2 near its critical point. A conducting metallic film, deposited on a thick glass plate, is used to provide the heat input to the fluid, and the fluid's thermal diffusivity is calculated from the measured temperature field. The optical method allows close monitoring of convective fluid motion which, it has been hypothesized, has led to erroneous conclusions from measurements made by more-conventional methods.

In addition to critical point experiments, several other projects are noteworthy because of the extreme ambient conditions involved. One of these is the measurement of the Joule-Thompson coefficient for water and steam in the critical region and in the vapor region at pressures up to 800 bar and temperatures as high as 800 C. Another is determination of the thermodynamic properties of solids undergoing shock impingement (in which pressures on the order of 10^{16} bar and temperatures of several thousand degrees are realizable).

The Institute for Thermodynamics has long been a source of new information in the area of two-phase heat transfer, and this area remains as a matter of prime interest. In boiling heat transfer, T. Diesselhorst is conducting a systematic investigation of the effects of convection flow velocity and surface conditions upon pool boiling and burnout heat flux. A similarly systematic program of research is being undertaken by P. Waas to determine the fundamental behavior of vapors undergoing dropwise condensation. In these latter experiments optical measurements play an important role, as they always have in the Institute, in determining active site density and the growth and distribution of individual drops. PTFE and precious metals are being used as coatings for the vertical heat transfer surfaces. K. Trambauer employs a sophisticated system of instrumentation and data acquisition to measure the phenomena associated with steam condensation on ice. The origin of this problem is the potential nuclear accident situation in which it was thought that rapid condensation of escaping steam would be an effective means of preventing overpressures in reactor container vessels.

Not all of the projects can be mentioned here, but I would like briefly to draw attention to the work of S. Bloss, who has developed an analytical model for the seasonal temperature distributions within lakes and has verified his predictions with field measurements (the results were excellent--so good that Bloss feels that he must have picked the right lake). The work of K. Bauer also deserves mention. He is making heat transfer measurements in high speed flow with special attention to the effects of pressure gradient and free-stream turbulence. The latter experiment involves the use of a large continuous-flow open-circuit wind tunnel blowing through a two-dimensional Laval nozzle with segmented heat-transfer surfaces. In all of the projects I saw, I was particularly impressed with the high quality of equipment available to the student researchers and the ideal allocation of space and facilities for each experiment. Because of the nature of most of this work, a good deal of specialized model work was needed, and each setup featured a considerable amount of innovative experimental design on the part of the student researcher.

At the Institute for Fluid Mechanics I was welcomed by Prof. Dr.-Ing E. Truckenbrodt, a well-known member of the illustrious German community of fluid dynamicists. His textbook on airplane aerodynamics, coauthored with H. Schlichting and long a standby of European students in fluid dynamics, is soon to be published in English as a single volume condensation of the two-volume original. Truckenbrodt, with becoming modesty, apologizes for contributing to the "literature explosion", but it is likely that the text will be most welcome in English-speaking countries. As in the past, Truckenbrodt's main interest is in providing engineering tools that are accurate and reliable,

and yet simple enough in concept and application to be of service to the designer. As leader of the fluid mechanics program at TU München, he has influenced his staff and students in this direction and, quite recently, has guided the research programs in directions that are in alignment with the changing needs of the industrial community. Thus while a fair amount of highly theoretical and basic work is yet to be found in the Institute, there are new areas opening up such as the aerodynamics of buildings and bio-fluid mechanics.

The bio-fluid mechanics projects are entirely theoretical and include the study of problems in topology related to unsteady flows, the boundary layer analysis of flows containing spherical particles, and the consideration of the flow of non-Newtonian fluids in arterial passages. In the aerodynamics of buildings, there is an analytical effort to solve the Navier-Stokes equations numerically for the flow past sharp-edged structures and to determine the diffusion of effluents in such flow fields. This work is complemented by an experimental program to determine the environmental impact of chimney exhausts. Other experimental activities, under the direction of R. Frimberger, include an investigation of flow phenomena in heating and ventilating equipment and a study to develop scaling techniques to estimate building wind loads from model tests.

Both experiment and theory are contributing to Truckenbrodt's results on the behavior of the flow past yawed wings in subsonic and supersonic flows, and there is a continuing interest at the Institute in the general area of measurement techniques. This includes a project presently underway to catalog the various experimental design parameters (such as geometry, materials, and thermal compensation) that can affect the output of pressure transducers. There are several fundamental studies in turbulent shear flows and the numerical characterization of turbulence by spectral techniques. Unsteady viscous flows are also of particular interest. In the area of rarefied gas flows, R. Friedrich has been a regular contributor to the body of available theoretical knowledge. Although this work is continuing, it is noteworthy that Friedrich now plans to direct his attention to theoretical problems in turbulence.

Truckenbrodt jokingly describes himself as the "son" of Schlichting and, therefore, the grandson of Prandtl. There certainly is a national heritage associated with the history of fluid mechanics in Germany, and although this is not something that is flaunted in German institutions, it stimulates a certain amount of awe in the visitor from the New World. In 1868, when the TU München was founded, such notables as Stokes, Rankine, Kirchhoff, Kelvin, Lord Rayleigh, Reynolds, Boussinesq, Joukowsky, and Lamb ranged in age from 49 to 19. It was the dawn of a golden age in fluid mechanics, and Prandtl, who was to earn his doctorate in elasticity at Munich, was nothing more than a gleam in his father's eye. (R.H. Nunn)

IEE INTERNATIONAL CONFERENCE ON MILLIMETRIC WAVEGUIDE SYSTEMS

With long-distance telephone traffic growing at rates between 3% per year for some countries and 27% for others, plans must be made for large increases in the capacities of their telephone networks over the next 10 or 20 years. The implementation of these plans is based on the available and anticipated technologies which, at present, include coaxial cables, microwave point-to-point radio links, satellite-borne relay stations, millimetric waveguide systems, and optical-fiber transmission.

Of these five, the first three are in widespread use but have the disadvantages of a bandwidth limited to about 25 MHz for coaxial cables, a wider but already very crowded spectrum for microwave radio, and the difficulties of the necessarily global administration of satellites. Optical transmission through glass fibers is being widely investigated and improved, but it has yet to undergo sufficient life testing, manufacturing quality control, etc., before firm plans for its commercial use can be made--perhaps in the late 1980s.

Work on millimetric waveguide systems, on the other hand, has been going on ever since the early 1930s, when Sergei Schelkunoff, George Southworth, and others at the Bell Telephone Laboratory found that electromagnetic waves will propagate through metal pipes. In particular, Southworth's 1938 patent on waveguides recognized the possibility of using pipes of circular cross section for the long-distance transmission of microwave signals. A circular waveguide allows these signals to propagate in rotationally symmetric modes designated $TE_{0,m}$ whose electric fields are confined to the θ direction and fall to zero at the wall of the waveguide, thus resulting in an unusually low attenuation of the signals per unit distance traveled.

This work has now reached the stage where millimetric-waveguide equipment is ready for installation in commercial service, and decisions are being made as to whether its high initial cost can be justified in terms of its expected benefits over the next two decades, during which the amount of traffic it carries can be increased relatively inexpensively by employing more and more of its extremely large bandwidth--about 80 GHz. In this context the Institution of Electrical Engineers sponsored a Conference on Millimetric Waveguide Systems at its London headquarters from 9 to 12 November devoted principally to the programs in this field of 6 countries--France, West Germany, Italy, Japan, the US, and the UK.

The British Post Office is making plans to install a waveguide system over the 123-km route between Bristol and Reading and to put it into regular service as early as 1982 (but 1986 was also mentioned). France and the US presented somewhat less definite schedules with comparable or slightly later target dates, but Italy and Japan did not offer any dates, although the 27% annual growth in telephone traffic in Japan as compared with 7% for the UK indicates a clear requirement. Germany, on the other hand, because of its lower growth rate, has decided against the implementation of a waveguide system. Starting in the latter 1980s, the millimetric waveguide systems will be supplemented by optical guided-wave systems. The latter will probably serve for shorter routes and for local distribution in densely populated areas because of the greater dispersion and attenuation per unit distance in glass fibers, which necessitate a somewhat shorter spacing between repeaters--perhaps 10 km as compared with 20.

The repeaters must in every case recover the original pulses from the digital signal and must produce a new, clean signal in order to keep the effects of noise and various system imperfections from building up and causing errors. Hence, the repeater locations are the places at which to branch out, taking off some channels of information and inserting others. The digitalization of a voice waveform is effected by looking at ("sampling") it 8000 times a second and usually representing each observed value by 8 binary digits. Because 8000/s exceeds twice the 3.4-kHz highest voice frequency, these samples suffice for the perfect reconstruction of the voice waveform at the receiving end, apart from the quantization error due to using only 7 or 8 digits. Thus, about 64,000 bits/s must be transmitted for each voice channel.

The British waveguide has a bandwidth of 80 GHz, extending from 30 to 110 GHz, which is divided into 128 bands of width 560 MHz--64 of them carrying signals in each direction at a rate of 250 Mbit/s each. The system thus will have a capacity of 250,000 two-way voice channels, which will be doubled when, later on, 4-phase modulation of the carrier frequencies is substituted for the initial binary phase-shift keying (PSK). The system will start out, however, by utilizing only the 30-to-50-GHz portion of the spectrum, leaving the higher frequencies for implementation later on with perhaps improved equipment.

On the last day of the Conference there was a visit to the UK Post Office Research Centre's new facilities at Martlesham Heath near Ipswich, Suffolk (75 miles northeast of London), where the Post Office's 14-km test link could be seen in operation carrying voice and color-television signals. Devices for its fabrication, installation, measurement, and maintenance were also displayed. Participating in the exhibition of equipment and techniques were not only representatives of the Microwave Transmission Systems Division and the Materials Division of the Post Office Research Centre, but also numerous

people representing the manufacturers who supplied portions of the system to the Post Office.

A very wide range of technologies goes into the creation of such a system, from the theory of electromagnetic propagation and the fabrication of millimeter-wave diode amplifiers to means for locating, removing, and replacing a damaged section of waveguide in the shortest possible time. The theory of random processes enters the picture not only in regard to the effect of noise upon the reliability with which binary digits can be transmitted but also in connection with the imperfections in the shape of the waveguide, which convert some of the desired TE_{01} mode into other modes, thereby attenuating the signal and rendering it more susceptible to the effect of noise. Thus, it is necessary to determine the power spectral densities of the curvatures, diameters, etc., of the waveguide as random functions of position along the guide in order to know what these geometric imperfections will do to each radio frequency in the guide. In particular, spatial frequencies up to 12 cycles per meter have detrimental effects, and hence a very careful measuring program is required along with fast Fourier transformation to obtain the required spectra.

The six countries' waveguide systems are similar in that all use approximately the same band of frequencies and all use waveguides with diameters between 50 and 70 mm. Similar approaches were developed independently to many problems, but the six differ considerably in other respects. For example, the French system uses only helical waveguide, and the British system uses it except in sharp bends; the US system uses dielectrically-lined waveguide for 99% of the route, inserting 1% of the helical waveguide for the suppression of spurious modes; and the Japanese system uses 20% of helical waveguide.

The French have built a 15-km test system between the headquarters of the Centre National d'Etudes des Télécommunications in Lannion and the satellite ground station at Pleumeur-Bodou, transmitting 560 Mbit/s via each carrier in the band from 31 to 60 GHz by means of 4-phase PSK to provide a total of 150,000 voice channels. But the 45-km German test system between Heidelberg and the Post Office's central engineering headquarters in Darmstadt, which was begun in 1974, was terminated in 1976.

Because of the 27% annual rate of growth of telephone traffic in Japan, a waveguide system is definitely being planned for that country, to begin commercial service by 1987, but no definite date has yet been set. Their system, called W-40G, is to use the 43-to-87-GHz band in 51-mm waveguide with a 15-km spacing between repeaters (on account of the relatively large amount of curvature of the route) to provide 300,000 two-way telephone channels, each carrier conveying 800 Mbit/s by means of 4-phase modulation.

An important difference between one country and another lies in the cost of acquiring rights of way for laying waveguides and building repeater stations. In the UK this cost appears to be lower than in the US, and space seems to be available in UK earthenware ducts for future optical fibers, whereas in the US new steel ducts will be required.

Conference sessions dealt with overviews of the six countries' systems, waveguide design and production, routing and laying, characterization of installed waveguides, rf multiplexing, repeaters, active components and devices, and system aspects. An ONRL report is being prepared that offers some further detail on the papers and on the discussions they engendered. But it may be of interest to report here the discussion concerning the question of the pipe suppliers' willingness to use the power spectral density (PSD) of the curvature as a criterion for the acceptance of their product. It was reported that, although the concept was not readily grasped by either vendors or buyers, they came to appreciate it because its use permitted the acceptance of lots that would otherwise have been rejected. Moreover, the periodicities in waveguide curvature showing up via the PSD were found by the Bell Telephone Laboratories to correspond to remediable flaws in the manufacturing process that could be corrected quickly--increasing the yield and improving the quality of the product in real time, as the PSD was evaluated by a microcomputer on the production line.

The Conference was attended by 241 registrants--half from the UK and a sixth each from the US and from France. A sixteenth each came from West Germany, Italy, and Japan, and there was a small scattering from five additional countries. The Soviet Union, which had, in its usual way, participated in the IEE's 1970 conference on "Trunk Telecommunication by Guided Waves", was invited to provide a member for the organizing committee of the present Conference, but there was no response whatever, just as there had been none in connection with the International Symposium on Information Theory that took place in Sweden in June 1976. (The hypothesis that all foreign travel by Soviet scientists and engineers had been cut off for want of foreign exchange in June was disproved, however, when five Soviet scientists showed up a week later at an international conference on fluid mechanics at Enschede, The Netherlands.) Even in the case of meetings in Eastern Europe, Soviet participants fail to arrive on time, and those who show up are likely not to be the authors of the papers in the program.

The 62 papers presented at this Conference are available in the xv + 250 compressed, two-column typewritten pages of the conference publication. It can be obtained for £12.10, overseas postage included, from Peter Peregrinus, Ltd., IEE Publication Sales Department, Station House, Nightingale Road, Hitchin, Hertfordshire SG5 1RJ, England. It contains a great deal of information about the many aspects of millimetric-waveguide communication systems and the various approaches that can be taken. It also includes a paper on a large radio-telescope whose elements are to be linked by means of millimetric waveguides; this connection involves many of the same problems and solutions as in the communication application. (N.M. Blachman)

BELFAST--PROGRESS IN THE THICK OF IT

My entry for the Understatement of the Year Award is: "There is a lot going on in Belfast these days." Because of an unfortunate relationship between the viciousness of events and their exposure in the media, however, I doubt that it is widely known that the statement is also true from the point of view of academic enterprise, an observation resulting from my recent visit to engineering departments at two Belfast schools of higher education. Queen's University of Belfast, as it has been known since 1908, was founded as Queen's College in 1845, the year before the disastrous potato famine in Ireland. About eight miles north of the city center, along Belfast Lough (Bay), is Newtownabbey where, in 1971, Ulster College of The Northern Ireland Polytechnic was founded. I found these institutions to be interesting in their similarities as well as in their differences, some of each of which will become apparent below.

At Ulster College my host was Prof. D. McCloy, whose reputation in the field of fluid power control, including the co-authorship of a well-received textbook, was one of the chief reasons for my visit. McCloy is Director of Studies of the School of Mechanical and Industrial Engineering of the Faculty of Technology, a position he has held since about two years ago when he "emigrated" from Queen's University. Thus McCloy is the new head of a new faculty in a new college, and the virtues and difficulties of his situation are apparent. There are about 5000 students at Ulster College, about 20% of whom are enrolled in engineering programs. Although the emphasis of the College is supposed to be on the Higher National Diploma--a sort of technology degree for extra-qualified technicians--this is a goal that is easier to state than to enforce. Many students seek the BSc and higher degrees, and there is an easily-understood restlessness among the young faculty to push themselves, and their courses, in the direction of more advanced engineering practices. McCloy does not openly discourage these trends, although it is clearly a difficult problem to maintain the technology emphasis while allowing and even promoting research activities for his faculty. It is a dilemma that is refreshing these days, though, since the building of a research program upon a foundation of hard-nosed practical engineering is somewhat the inverse of the problem

facing many older institutions. Queen's University is an example of the latter, and there is a tangible air of competition between the two institutions.

McCloy's most recent research interests have been the use of optimization techniques in the design of hydraulic servomechanisms and the study of cavitation effects in fluid power systems. These activities have been temporarily limited, however, on account of his administrative responsibilities and his involvement in the emerging research programs of his staff.

Mr. Ian Laurenson is conducting an extensive Science Research Council-supported experimental program to determine optimum design criteria for hydrostatic face seals. His current main interest is in the blockage of the lubricant in these devices, and his efforts have thus far led to several design innovations which limit the extent to which oil contaminants reduce seal performance.

Dr. Ian Stevenson has developed a highly refined axial vortex amplifier for use with liquids. His design is the result of a matrix of experiments that have determined the optimum geometries for the vortex chamber and the exhaust passage. His amplifier features a conical pickoff element in which much of the control flow present in the exhaust is isolated from the main flow. The result is a large increase in turn-down ratio (throttling effect). The group has also worked with bistable fluidic amplifiers for use with liquids, and future research in fluid control devices will emphasize the control of liquids, rather than gases, by fluidic means.

In the area of fluid power control, Dr. A. Martin is conducting an investigation into the non-linear behavior of servomechanisms. His experimental equipment is designed to measure the breakout forces acting in the actuators of such systems, and his preliminary conclusion is that in typical systems it is the servovalve characteristics that dominate the nonlinear effects, many of which have been erroneously attributed to the actuator.

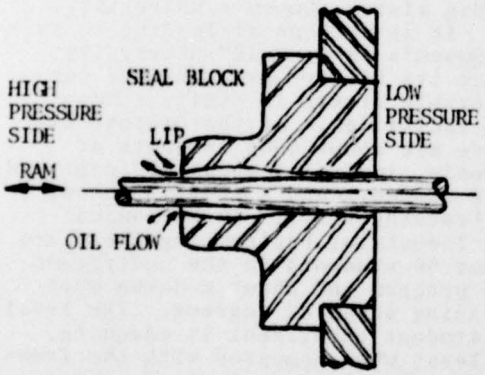
McCloy's leadership position had led him into another area that might be just as rewarding as research, if not to him then certainly to others. The economic situation in Belfast, to make another understatement, is sticky. As the Head of an engineering faculty, and as someone who is personally concerned with the prosperity of the local community, McCloy has begun to develop a program to answer the question: "What can the Polytechnic do for local industry?" He has invited representatives of nearby industrial firms to come to the campus and discuss their difficulties with his staff. McCloy feels that this has been eminently successful--within only a few weeks his engineering experts have come up with several ideas that have been put to use and are paying off. The distinguishing features of these ideas are their relevance and simplicity: a new oyster-bed complex that has created 75 jobs, a production scheme for waterproof clothing that benefits the local fishing and textile industries, and several other projects custom-made to fit the needs and capabilities of local consumers and manufacturers. McCloy is obviously excited about these initiatives, and he is pressing himself and others to expand the program. Community awareness is a matter of mission at Ulster College and it is likewise of increasing concern to her scholarly big sister, Queen's University.

It is perhaps misleading to talk of Queen's as an "old" university, since its history has included considerable growth in staff, students, and facilities. At the present time there are about 6000 students at Queen's, including about 600 postgraduate students and a similar number of teaching staff. In Mechanical and Industrial Engineering there are about 90 students in the undergraduate program and about a dozen more pursuing advanced degrees. The level of student enrollment is adequate, at least when compared with the free-world scene in technical education, but there is plenty of hope at Queen's that it will not get worse. The opening of the Polytechnic "just down the street" has not helped matters and, in fact, several of the faculty feel that the expansion of educational facilities in Northern Ireland has been irresponsible. (Some with whom I talked used stronger words.)

In M.E. at Queen's there are several areas of research strength, including very-high-pressure technology (under the Department Head, Prof. B. Crossland) and two-stroke engine

design under the supervision of Prof. G.P. Blair. The latter effort has established a worldwide reputation for Queen's as a source of innovation and expertise in small engines for everything from lawn mowers to motorcycles, and the designs of many American, European, and Japanese vehicles show a marked Belfast influence. This is a bit of a sore point in the Department as many feel that it has been a great deal easier to penetrate foreign industries than those in the UK.

Research in fluid mechanics is not prevalent at Queen's, but the work in high-pressure systems has led to some concern for fluid flow, especially in the seals area. The project of Dr. M.J. Gray is noteworthy in this regard and has been mentioned in an earlier article (ESN 29-11:459). As a doctoral student under the supervision of Dr. W.J. ("Red") Skelton, Gray began his work in elastohydrodynamic lip seals, and he is now doing Post-Doc work on the same problem. The configuration that interests Gray is sketched below, with the deformation of the seal highly exaggerated. The internal pressures are



in the 50-100 kpsi range and initial gap clearances are on the order of a few μm. Using the finite-element method, Gray has had great success in predicting the gap deformation and the pressure distribution within the gap. The pressure-dependency of the oil viscosity is a major consideration at these pressures, and has led to some rather unexpected results such as the strong influence of the direction of shaft motion. Gray's current efforts are directed towards the creation of a design computer program to tailor the seal configuration to obtain specific gap contours and pressure distributions. The goal here is an optimum design that will limit leakage and maximize the operating range (pressure and shaft speeds) of the seal. The effort could lead to the use of such seals at relatively low pressures and with low-viscosity liquids such as water. The result of such a breakthrough might be, for instance, high-pressure water pumps for jet cutting systems; current designs require pressure intensifiers.

Another research program related to fluid mechanics is the gas bearing work of Dr. I. Donaldson and his students. Through the use of porous inserts, Donaldson has operated these bearings at supply pressures up to 500 psi and does not feel that the limit has yet been approached. The resulting high load-bearing capacities greatly extend the range of application of gas bearings, but there is a problem: over a fairly wide range of pressure the gas film can collapse or oscillate on account of flow instabilities within the porous passages. The present effort is aimed at characterizing those instabilities and defining stability envelopes for various bearing designs. Another problem is manufacturing repeatability in the fabrication of the porous insert. These sintered metal discs must be faced after assembly in the bearing and, owing to the difficulty of the machining operation, flow coefficients may vary by as much as a factor of 10. This problem provides a second main area of Donaldson's concern.

At Queen's there is an intriguing operation known as the Low Cost Automation (LCA) Center. There are 15 of these in the UK, and the one in Belfast was founded by McCloy and his colleague, Dr. E.K. Beatty, and has continued to thrive after McCloy's departure. The Center is independently financed with minimal government backing and is a tenant activity at the University. In essence, the goal of LCA is to assist local small manufacturers in improving their operations by means of simple and straightforward automation schemes. This is not a technology-transfer exercise in the sense of applying aerospace-age know-how to local industry. The Center is mainly for the benefit of the backyard type of production that has been using a sort of Neanderthal technology.

Beatty gave me a whirlwind tour of his lab, which is a veritable gadgeteer's paradise. Simple pneumatic and electro-pneumatic systems abound, all in working order, as demonstration devices for customers who often begin their relationship with LCA as students in one of the Center's short courses. Examples of the many automation problems solved by the Center include punching holes in belts, blowing the meat out of prawn shells, and bracing systems for the manufacture of picture frames. The Center also will design, test, and build more sophisticated systems such as the automatic bobbin grader and sorter destined for the Northern Ireland textile industry. The Center appears to be most profitable, certainly if you ask turned-on Beatty, and, in my opinion, this success is in no small way due to the attention given to local small businesses.

In reporting a trip to Belfast it is hard to resist commenting on "The Troubles". I had resolved to avoid these issues during my visit but this proved impossible both because of the siege atmosphere in the area and the fact that my gracious hosts were quite willing--even anxious--to talk about the problem. Everyone in the area has a friend or relative who has been in some way entrained in the events of the times in Northern Ireland. Having been well conditioned by the media, I had expected to find the colleges in a state of disarray and dejection. This is not the case. Work goes on in teaching and research, and there is a determination to minimize the impact of what many consider to be a tribal war. There is tension, but this is supressed, if only just beneath the surface. Northern Ireland has experienced an incredible sequence of economic, political, and demographic upheaveals which, in recent years, have seemed to be almost simultaneous. There is widespread frustration in academia, but there is also an attitude of enterprise in programs of education and research, and an eagerness to relate these to the needs of the community. In spite of the circumstances, and partly because of them, there is progress. (R.H. Nunn)

GENERAL

ANVAR--RESEARCH DEVELOPMENT THE FRENCH WAY

Founded in 1968, ANVAR, the French National Agency for Research Development, has as its mission to prospect scientific laboratories and look for ideas which might be developed and used in technical or commercial applications. This chase after novel ideas, their fostering and the scouting for potential industrial customers is carried out with a relatively small staff and modest means. There are 51 full-time and 16 part-time scientific personnel, and the 1975 budget was about 37M FF (approximately $7.4 M). Since its creation, ANVAR has analyzed about 10,000 folders describing potential inventions of which there were about 2000 in 1975 alone. It should be pointed out that a very similar organization, the National Research Development Corporation, exists in the UK and operates very much like ANVAR.

ANVAR customers come from private and public laboratories, universities and individuals, as well as from small and large firms. Industrial giants are not too interested in ANVAR because they have their own services to look after and promote their inventions. Yet, when they stumble on an invention which is outside their field of expertise, some of these large industries resort to ANVAR's services. Statistics show that only 5% of ANVAR patents originate from ideas submitted by these firms. The smaller French firms are those that look to ANVAR as a partner capable of seeing them through the various, often very involved and costly, steps which must be followed before an idea becomes marketable. Of the 430 French firms that approached ANVAR in 1975, about 360 had less than 500 employees. Even though it is the smaller firms that seek out this service, the rejection rate is high as only 19% of their patents receive the go-ahead for development, The bulk of the patents come from scientists working in universities or in public laboratories such as those belonging to or affiliated with

the Centre National de la Recherche Scientifique (CNRS), and from national institutes such as the Institut Pasteur. Only 5% of accepted patents come from individuals.

Mr. P. Rognon, one of ANVAR's Assistant Directors, explained that the agency is trying to establish an ongoing, personal dialogue with researchers and industrialists. Individual contact between an ANVAR representative and a scientist is fostered through laboratory visits, telephone conversations, etc., during which the two discuss the research underway and its potential for conversion into a practical, financially sound application. According to Rognon, ANVAR is trying to develop a "conditioned reflex" in the scientist's mind so that he always remains alert to potential applications of his research. To reach industrialists, ANVAR has several specialized publications: the *Marché de l'Innovation* is a magazine published in 4 languages; a periodical called *SICANVAR (Service d'Information Confidentielle de l'ANVAR)* is a confidential publication which is sent to certain industrialists and which describes some patents which might be of interest to their particular specialty. ANVAR also attends most of the national and international trade fairs.

Once a given idea has been selected, ANVAR may or may not go after a patent depending on whether protection of the invention is desirable or possible. By the end of 1975, ANVAR held a total of some 4500 patents, and during that year it took out 1400 patents in France alone protecting some 1000 inventions. Protection of an invention is usually sought in other countries, especially in the fields of energy, food or drugs. In 1975, 3140 patents were taken by ANVAR outside of France, the US leading with 18%, followed by the Federal Republic of Germany with 15%, the UK 11%, and Japan 8%; the remaining European countries accounted for some 33%. ANVAR's revenues, resulting from the sale of these patents, amounts to some 412.4M FF which is roughly 1/3 of its total budget.

It takes from 6-8 years to bring an idea to its marketable stage. This is especially true for new drugs that have to undergo rigorous tests before being allowed on the market. A given research item might be considered completed as far as its theoretical aspect is concerned, but it is far from being marketable. Thus, the research laboratory is no longer interested in it and the industrialist is put off by the cost of marketing it. ANVAR intervenes either with some of its own funds or with joint CNRS funds (about 1.7 M FF is allocated for this special task) and fosters that idea from its completed research stage to the point at which it becomes marketable.

ANVAR itself is not allowed to exploit research ideas. It is the inventor's and the industrialist's go-between. The inventor's financial remuneration varies greatly: Scientists belonging to the INRA (Institut National de la Recherche Agronomique), for example, are not entitled to any financial compensation. Those at the CNRS and at universities receive a percentage of the sale resulting from their invention, be it sold outright or in the form of royalties. Sometimes the entire research team or even the laboratory in which the idea originated is rewarded.

In recent years ANVAR has paid particular attention to research dealing with the areas of public transport, food and agriculture; for example, a process has been developed by which cheese is made by ultra-filtration of milk. Energy is also an area of special interest; solar pumps and solar houses have been designed. In this connection, ANVAR has created a new company called SOFRETES (Société Française d'Etudes Thermiques et d'Energie Solaire). Several public laboratories and institutes have turned to ANVAR to market their research ideas. Some of these are the CNES (French NASA), CNEXO (Center for the Exploitation of Oceans), INRA, Institut Pasteur, ONERA (National Aeronautical Research Center), and the ITF (Textile).

Finally, ANVAR is attempting to spread its influence both on the national and international levels. With the creation of 18 new regional centers it hopes to detect and foster local inventors and inventions, and to proceed to a local selection of applicants before sending any folder to its headquarters in Paris. These local centers are also trying to find interested industrialists. On the international level, ANVAR has signed bilateral agreements with a number of

similar organizations in several countries (e.g., Battelle Development Co., Research Corp., and Arthur D. Little in the US). These agreements call for an exchange of interesting ideas and provide a network of contacts and correspondents. In this way, ANVAR helps a French industrialist or inventor to acquire foreign patents or to sell his license abroad. (A. Barcilon)

OCEAN SCIENCES

MARINE SCIENCE IN GREECE

The Institute of Oceanographic and Fisheries Research (IOKAE) is located at Agios Vosmas, on the Northeast Coast of the Aegean Sea, less than a mile from the Athens Airport. Although the Institute was established in 1965, the research staff did not arrive until 1972. The Institute is under the Ministry of Culture and Science and is the only marine science laboratory in Greece. It is governed by a 5-man Board of Directors--3 university professors, the Director of the Naval Hydrographic Program and an "ichthyologist fisheries businessman". The Director General of the Institute Dr. Alexander Stephanidis, an ichthyologist, assumed the post in 1974. There are about 70 employees (all Greek citizens) 30 of whom have professional qualifications.

Organizationally the IOKAE is divided into two scientific departments (Oceanographic and Fisheries) and an administrative support department. The Oceanography Department comprises physical, chemical, biological, geological, and limnology sections. The Fisheries Department is composed of Marine Fisheries, Fisheries of Inland Waters, Aquaculture of Commercially Important Species, and a number of fisheries stations.

While the research goals of the Institute generally encompass a broad spectrum of oceanology, the emphasis of many of the programs underway is on various aspects of marine pollution. Dr. E. Verykokakis, of the Oceanographic Department, explained that one of their major efforts involves the collection of water and biological samples throughout the coastal regions around Athens and some of the nearby islands. This pilot project, parts of which are but one year old, has as its chief objectives the assessment of heavy metal and pesticide content in coastal waters and the acquisition of baseline data. Water samples are being obtained routinely in the coastal zones around Athens in regions of sewage outfalls and "clean areas", to depths of 70 m and occasionally to 400 m. The samples are analyzed for nutrients such as phosphates, nitrates, silicates and ammonia. Levels of dissolved oxygen also are determined as are those of heavy metals such as cadmium and copper.

Geologists have been measuring sediment transport throughout the past year to depths of 10 cm below the sea floor. Mr. C. Neophotistos, of the Marine Sedimentology Laboratory, explained that they are particularly interested in the problem of industrial waste contained in rivers flowing from Yugoslavia as well as from within Greece. The former feed directly into Greece, and apparently little effort is being made in Yugoslavia to prevent such pollution. Within Greece, the introduction of new industry in certain areas as part of a national program of decentralization is creating situations that could generate serious pollution problems.

A detailed study of the benthic community existing 15-20 cm above the sea bottom in water depths ranging from 25-450 m, is also being conducted as part of the pollution assessment program. This 3.5 year old program, under the direction of Mr. A.J. Zarkanellas, involves periodic sampling at designated stations in clean areas and near sewage outfalls in conjuction with the water chemistry program mentioned earlier. Three samples per station are being obtained from the hard-packed sand bottom with a Van Veen grab sampler. While the study is a continuous one, the results to date show, among other things, a significant decrease in both number and species of polychaetes as a function of distance from the outfalls. Because the industries contributing to the pollution existed prior to the start of the study, no baseline data are available in these areas. Zarkanellas, however, hopes to obtain

baseline data in other parts of Greece and is beginning to do so in northern regions.

In the fisheries program, several projects are underway. One of these, under the direction of Dr. S.E. Papoutsoglou, involves the development, care and feeding of rainbow trout. Greek waters provide an almost ideal natural habitat for this fish which happens to be very popular in Greece. In addition to almost perfect water temperatures (14 C with a variation of only 1 C during the year) the oxygen concentration is also ideal (about 8-11 ppm). Papoutsoglou is trying to increase both size and growth rate of the trout by nutritional means. In particular, he is attempting to develop a highly nutritious artificial food from products orginating solely within Greece. At present, their hatcheries need to import much of their fish food from Holland and other countries. While the fisheries program is small, Papoutsoglou hopes to expand it to include eels, carp and the fish *Chrysophrys aurata*, all of which can be raised in brackish water. The fisheries program also includes a study designed to determine the population dynamics of local demersal fish. Parameters under investigation include age, growth rate, mortality and fecundity.

Dr. Marios Ionnou, whose interests seem to be primarily marine botany, is studying marine fouling organisms with the objective of developing improved anti-fouling coatings for both metal and wood. Such information is sorely needed, especially by the Greek fishing fleet. Ionnou is a senior scientist who for about 25 years was director of a marine scientific laboratory and an aquarium on the island of Rhodes. He is especially interested in the uses of seaweeds. He was the first in Greece to extract agar from seaweed many years ago and also was the first to observe diatoms in the Mediterranean Sea. He expressed great disappointment that no one in Greece currently is exploiting the commercial potential of seaweeds. Ionnou mentioned, in passing, that he also had been involved in the culture of sponges around the island of Kalimnos a few years ago. In this instance, the sponges were grown on vertically-suspended lines in much the same fashion as are oysters and mussels.

The general impression one receives at IOKAE is that it houses a group of hard working, dedicated, but frustrated individuals. In addition to the usual governmental red tape, the frustration is due to the realization that while there are serious national problems related to the marine environment which pose a threat to both commerce and tourism in a nation intimately associated with the sea, the current level of effort will at best be marginally effective. It is ironic indeed that in a relatively small nation, having as much as 25,000 km of coastline, the recently organized IOKAE is the only facility devoted to the study of the marine environment. It is also surprising that there is no existing program for training marine scientists in Greece. Those who are currently working in the marine science field either were trained abroad or moved into the field from other scientific disciplines because of personal interests.

Stephanidis, as well as several members of the staff, commented on the great need for additional trained marine scientists. Stephanidis said that should scientists from other countries be interested in spending time at the Institute (say 1-2 years or perhaps longer) arrangements could be made to support them except for salary. He would be particularly interested in physical oceanographers and persons with experience relating to problems of the tuna industry.

In the writer's opinion, time spent at the Institute, which has an eager staff and reasonably well-equipped laboratory facilities, would offer a challenging opportunity for the right persons to assist in building an important marine science program in a country both needing and seeking assistance. Interested individuals should keep in mind, however, that the need is for help in attacking problems existing in Greek waters, and not for someone whose principal interest would be to work on his own research project. The existing problems, however, are by no means unique, and a logical meshing of interests should not be difficult. While knowledge of the Greek language obviously would be advantageous, most of the professional staff speak English. Interested parties should write to: Dr. Alexander Stephanidis, Institute of Oceanographic and Fisheries Research, Agios Kosmas, Ellinikon, Athens, Greece.

Were the writer trained in the appropriate fields, 1-2 years in a country as beautiful and friendly as Greece would be a matter to consider seriously. (J.W. Miller)

NEWS & NOTES

NOISE RESEARCH IN THE UK

The Acoustics Unit of the National Physical Laboratory has recently reissued its *Index of Current Noise Research in the UK*, last issued in 1970, as NPL Acoustics Report AC 76 dtd Sept. 1976, E.N. Bazley.

This report provides a brief of each of some 350 research projects in about 100 research establishments. Coverage includes the Universities, and other educational institutions, Government, Public Corporations, Research Associations and Industry.

It should be particularly useful to those working in the aero and environmental noise areas.

Copies of the report are availabl from DDC or NTIS.

PERSONAL

The Queen's New Year Honours List: Prof. Sir John Fleetwood, FRS, formerly Professor of Mechanical Sciences and Head of the Dept. of Engineering, Cambridge University, was named Baron and a Life Peer. Named Knights Bachelor (KB) were Prof. James Baddiley, FRS, Director of the Microbiological Chemistry Research Laboratory, U. Newcastle upon Tyne; John Warcup Cornforth, FRS, Royal Society Research Professor, Sussex U.; Prof. David Gwynn Evans, lately Director, National Institute for Biological Standards and Control; and James Eric Smith, FRS, for services to marine biology. Named Companions of the Bath (Civil Division) (CB) were I.B. Dick, Director, Building Research Establishment, Dept. of Environment; and R.J. Lees, Director of the Radio Signals and Radar Establishment, Ministry of Defence.

Dr. M.J. Bevis, Reader in Metallurgy and Materials Science, Liverpool U., has been appointed to the newly created Chair in Non-metallic Materials at Brunel U. from 1 May. He will become head of the former Department of Polymer Science and Technology.

Dr. F.J. Bryant, Reader in Solid State Physics, Hull U., has been appointed to a personal Chair at that University.

Dr. H.E. Davies, Project Manager of Data Handling Division, CERN, Geneva, has been appointed Director of the Computer Unit at Exeter U. as of 1 February 1977.

The title of Emeritus Professor has been conferred by Liverpool U. upon Professor Cecil Gray, Professor of Anaesthesia and Dean of the Faculty of Medicine.

The German Physical Society has awarded its 1976 Physics Prize to Dr. Werner Lauterborn, an acoustician, of the 3rd Physical Institute of the University of Göttingen in recognition of his work in the field of cavitation and the dynamics of cavitation bubbles.

At the University of London constituent colleges, the title of Professor of Engineering Science has been conferred on J.S. McDougill, King's College and Professor of Chemistry upon D.N. Kirk at Westfield College.

OBITUARIES

Sir David Martin, Executive Secretary of the Royal Society, died 16 December at the age of 62. Although he had a doctorate in Chemistry, Sir David's great administrative ability led to his holding many important posts in various local and international societies, and he was well known throughout the scientific world for his skill in drafting reports, statutes and other documents required in the administration of such organizations.

Professor Hans Rumpf, holder of the first Chair in Process Engineering in a German university located at the U. of Karlsruhe, died 4 December. The Institute he built up at Karlsruhe became internationally famous in the field of powder technology. More recently, he brought together several Institutes at the University to form what is essentially the first Department of Chemical Engineering in Germany.

ONRL REPORTS

R-11-76 FRANCE'S GRANDES ECOLES by A. Barcilon

A review of the characteristics of a unique system of higher education found in France: The "Grandes Ecoles". The report looks in some detail at the engineering schools in France and provides an overall view of French engineering.

R-12-76 ELECTRONIC AND TELECOMMUNICATION ACTIVITIES IN EGYPT by D.K. Cheng

This report summarizes the existing and planned activities in the field of electronics and telecommunications in Egypt. Activities in the research, industry, and service sectors are described separately and some proposed future plans are given. A description of a planned Pan-Arab space-satellite network is also included.

R-13-76 OBSERVATIONS ON EUROPEAN LOW-TEMPERATURE PHYSICS RESEARCH: AN ANNOTATED DIRECTORY OF LOW-TEMPERATURE PHYSICS IN BRITISH UNIVERSITIES AND SOME COMMENTS ON THE LOW-TEMPERATURE PHYSICS PROGRAMS IN EUROPE by T.A. Kitchens

This report summarizes the author's observations on low-temperature physics research in Europe during the period of August 1975 - August 1976. It features an annotated directory of low-temperature research in British Universities, and contains comments on visits to Continental institutions, both of which supplement ONRL Report D-15:1973 "Directory of European Low-Temperature Research" by E. Edelsack *et al.* Emphasis in the comments is on refrigeration and low-temperature components rather than on superconductivity.

C-26-76 THE 12TH INTERNATIONAL SYMPOSIUM ON APPLIED MILITARY PSYCHOLOGY by J.W. Miller

This report describes the 12th International Symposium on Applied Military Psychology, held in Paris in April 1976. The Symposium was attended by 24 representatives from 10 countries. The theme of the conference was "The contribution of psychologists to military effectiveness". Each participant was requested to bring examples of successful and unsuccessful programs which were initiated and/or implemented by behavioral scientists. Topics of discussion included recruitment and selection of armed forces personnel, training programs, conscientious objectors, the growth of unions in the armed forces, personnel research and training programs, leadership training, and the role of the psychologist in the armed forces.

C-32-76 FROM SOUP TO NUTS--THE VIIth INTERNATIONAL CONGRESS ON RHEOLOGY by E.A. Kearsley

Brief summaries are given of many of the 270 papers presented and an effort has been made to develop an overall impression of what is going on in rheology these days. The report is meant to serve as a *Guide Michelin* to the tourist travelling through the Proceedings. Topical coverage includes constitutive equations for polymers, crystalline polymers, rubber elasticity, dilute solution theory, extensional and convergent flows of melts and solutions, chemorheology and aging, birefringence in polymers, block polymers, thermodynamics of viscoelasticity, rheological fluid mechanics, new devices and measurement techniques, technological polymer rheology, melt fracture, failure of plastics, drag reduction, biorheology, granular media, metals, paper and cloth, and gases.

C-33-76 SACLAY CONFERENCE ON DIFFUSION IN CONDENSED MEDIA by L. Slifkin

This report on the 19th Colloque de Métallurgie, held by the Institut Natural des Sciences et Techniques Nucléaires in June 1976, briefly summarizes the review lectures and focuses attention on the main results reported in the poster sessions. A picture is thus given of the rather extensive interests and developments in France in the general area of diffusion in solids.

C-35-76 VIGILANCE REVISITED by R.R. Mackie and J.A. Nagay

This report summarizes a meeting held in St. Vincent, Italy (Aug. 1976) in which 65 specialists from 14 countries discussed and presented papers on "Relationships among Theory, Physiological Correlates, and Operational Performance". Problem areas considered included vigilance decrement encountered during the operation of ground and airborne vehicles, sonar and radar systems, industrial equipment, and a variety of other situations. Comparisons were drawn between the findings of laboratory and field experiments particularly as the emphasis has shifted during the past few years to field studies.